

Detailed Member Calculations

Units: N&mm

Regulation: ASCE 41-17

Calculation No. 1

beam B1, Floor 1

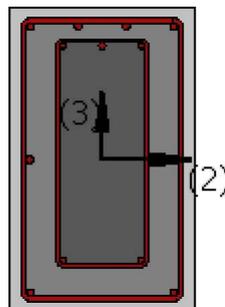
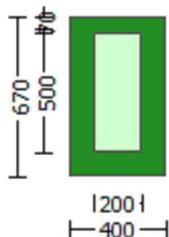
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: Start

Local Axis: (2)



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

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.85$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$

New material of Primary 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 Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$
New material of Primary 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, $L = 3000.00$
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with $l_o/l_{o,min} = l_b/l_d = 0.30$
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, $M_a = -1.1740586E-010$
Shear Force, $V_a = -5.4482097E-014$
EDGE -B-
Bending Moment, $M_b = -4.6355638E-011$
Shear Force, $V_b = 5.4482097E-014$
BOTH EDGES
Axial Force, $F = -3615.022$
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)
 $p_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 1.1740586E-010$
 $V_u = 5.4482097E-014$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 167551.608$
 $V_{s1} = 167551.608$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 500.00$
 $s = 150.00$

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

Vs2 = 0.00 is calculated for core, with:

$d = 160.00$

$A_v = 100530.965$

$f_y = 500.00$

$s = 300.00$

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

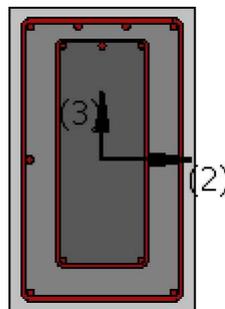
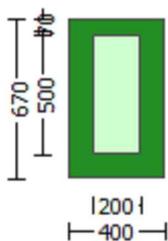
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

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, $\gamma = 0.85$

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

Consequently:

Jacket

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

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

Concrete Elasticity, $E_c = 26999.444$

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Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
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 = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
#####
External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping
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Stepwise Properties
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At local axis: 3
EDGE -A-
Shear Force, Va = 9840.634
EDGE -B-
Shear Force, Vb = 9840.632
BOTH EDGES
Axial Force, F = -2237.255
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Asl,t = 709.9999
-Compression: Asl,c = 1668.186
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 709.9999
-Compression: Asl,com = 1266.062
-Middle: Asl,mid = 402.1239
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Calculation of Shear Capacity ratio , Ve/Vr = 0.44897845
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 = 250619.824
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.6117E+008
Mu1+ = 2.1156E+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- = 3.6117E+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-) = 3.6117E+008
Mu2+ = 2.1156E+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- = 3.6117E+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 = 9840.634, is the shear force acting at edge 1 for the the static loading combination
V2 = 9840.632, is the shear force acting at edge 2 for the the static loading combination

Calculation of Mu1+

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

$$\mu = 9.5303512E-006$$

$$Mu = 2.1156E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu, c_o) = 0.00514506$$

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

$$\text{From (5.4b), TBDY: } \mu = 0.00514506$$

$$w_e \text{ (5.4c)} = 0.00169139$$

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

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$$

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

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25223$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25908$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft1 = 466.8167$$

$$fy1 = 389.0139$$

$$su1 = 0.00512$$

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

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

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

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

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

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

$$\text{with } fs1 = (fs,jacket * Asl,ten,jacket + fs,core * Asl,ten,core) / Asl,ten = 389.0139$$

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

$$y2 = 0.00140044$$

$$sh2 = 0.0044814$$

$$ft2 = 466.8167$$

$$fy2 = 389.0139$$

$$su2 = 0.00512$$

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

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

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

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

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

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

$$\text{with } fs2 = (fs,jacket * Asl,com,jacket + fs,core * Asl,com,core) / Asl,com = 389.0139$$

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

$$yv = 0.00140044$$

$$shv = 0.0044814$$

$$ftv = 466.8167$$

$$fyv = 389.0139$$

$$suv = 0.00512$$

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

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

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

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

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

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

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

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

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

$$1 = Asl,ten / (b * d) * (fs1 / fc) = 0.03337198$$

$$2 = Asl,com / (b * d) * (fs2 / fc) = 0.05950845$$

$$v = Asl,mid / (b * d) * (fsv / fc) = 0.01890095$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 33.00$$

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

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

$$1 = Asl,ten / (b * d) * (fs1 / fc) = 0.04123408$$

$$2 = Asl,com / (b * d) * (fs2 / fc) = 0.07352802$$

$$v = Asl,mid / (b * d) * (fsv / fc) = 0.02335381$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$su (4.9) = 0.14317227$$

$$Mu = MRc (4.14) = 2.1156E+008$$

$$u = s_u(4.1) = 9.5303512E-006$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_1 -

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

$$u = 9.8792908E-006$$

$$\mu = 3.6117E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu_c, \mu_{cc}) = 0.00514506$$

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

$$\text{From (5.4b), TBDY: } \mu_c = 0.00514506$$

$$\mu_{cc}(5.4c) = 0.00169139$$

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

$$a_{se1} = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i21} = 975400.00$$

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

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i22} = 557856.00$$

$$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.25908$$

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

$$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25223$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$p_{sh,y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25908$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

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

$$l_0/l_{ou,min} = l_b/l_d = 0.30$$

$$su_1 = 0.4 * esu_{1,nominal} ((5.5), TBDY) = 0.032$$

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

For calculation of $esu_{1,nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.

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

$$\text{with } fs_1 = (f_{s,jacket} * A_{s,ten,jacket} + f_{s,core} * A_{s,ten,core}) / A_{s,ten} = 389.0139$$

$$\text{with } Es_1 = (E_{s,jacket} * A_{s,ten,jacket} + E_{s,core} * A_{s,ten,core}) / A_{s,ten} = 200000.00$$

$$y_2 = 0.00140044$$

$$sh_2 = 0.0044814$$

$$ft_2 = 466.8167$$

$$fy_2 = 389.0139$$

$$su_2 = 0.00512$$

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

$$l_0/l_{ou,min} = l_b/l_{b,min} = 0.30$$

$$su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,

For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.

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

$$\text{with } fs_2 = (f_{s,jacket} * A_{s,com,jacket} + f_{s,core} * A_{s,com,core}) / A_{s,com} = 389.0139$$

$$\text{with } Es_2 = (E_{s,jacket} * A_{s,com,jacket} + E_{s,core} * A_{s,com,core}) / A_{s,com} = 200000.00$$

$$y_v = 0.00140044$$

$$sh_v = 0.0044814$$

$$ft_v = 466.8167$$

$$fy_v = 389.0139$$

$$suv = 0.00512$$

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

$$l_0/l_{ou,min} = l_b/l_d = 0.30$$

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

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

considering characteristic value $fsyv = f_{sv}/1.2$, from table 5.1, TBDY
For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered

characteristic value $fsy_v = f_{sv}/1.2$, from table 5.1, TBDY.

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

$$\text{with } f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 389.0139$$

$$\text{with } Es_v = (E_{s,jacket} * A_{s,mid,jacket} + E_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 200000.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.05950845$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.03337198$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.01890095$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

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

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

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

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.07352802$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.04123408$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.02335381$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$s_u(4.9) = 0.17343568$

$M_u = MR_c(4.14) = 3.6117E+008$

$u = s_u(4.1) = 9.8792908E-006$

Calculation of ratio I_b/I_d

Inadequate Lap Length with $I_b/I_d = 0.30$

Calculation of M_{u2+}

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

$u = 9.5303512E-006$

$M_u = 2.1156E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.00027032$

$N = 2237.255$

$f_c = 33.00$

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

Final value of α : $\alpha^* = \text{shear_factor} * \text{Max}(\alpha, \alpha_c) = 0.00514506$

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

From (5.4b), TBDY: $\alpha_c = 0.00514506$

$\alpha_w(5.4c) = 0.00169139$

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

$\alpha_{se1} = 0.14776895$

$b_{o,1} = 340.00$

$h_{o,1} = 610.00$

$b_{i2,1} = 975400.00$

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

$b_{o,2} = 192.00$

$h_{o,2} = 492.00$

$b_{i2,2} = 557856.00$

$\text{psh}_{,min} * F_{ywe} = \text{Min}(\text{psh}_{,x} * F_{ywe}, \text{psh}_{,y} * F_{ywe}) = 1.25908$

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

 $\text{psh}_{,x} * F_{ywe} = \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 2.25223$

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

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

No stirrups, $n_{s_1} = 2.00$

$h_1 = 670.00$

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

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

No stirrups, $n_{s_2} = 2.00$

$h_2 = 500.00$

 $\text{psh}_{,y} * F_{ywe} = \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 1.25908$

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

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

No stirrups, $n_{s_1} = 2.00$

$h_1 = 400.00$

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

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

No stirrups, $n_{s_2} = 2.00$

$h_2 = 200.00$

Asec = 268000.00
 s1 = 150.00
 s2 = 300.00
 fywe1 = 694.45
 fywe2 = 694.45
 fce = 33.00
 From ((5.A.5), TBDY), TBDY: cc = 0.002
 c = confinement factor = 1.00
 y1 = 0.00140044
 sh1 = 0.0044814
 ft1 = 466.8167
 fy1 = 389.0139
 su1 = 0.00512
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 lo/lou,min = lb/lb = 0.30
 su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
 From table 5A.1, TBDY: esu1_nominal = 0.08,
 For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
 characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.
 with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
 with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
 y2 = 0.00140044
 sh2 = 0.0044814
 ft2 = 466.8167
 fy2 = 389.0139
 su2 = 0.00512
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 lo/lou,min = lb/lb,min = 0.30
 su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
 From table 5A.1, TBDY: esu2_nominal = 0.08,
 For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
 characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.
 with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
 with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00140044
 shv = 0.0044814
 ftv = 466.8167
 fyv = 389.0139
 suv = 0.00512
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 lo/lou,min = lb/lb = 0.30
 suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
 From table 5A.1, TBDY: esuv_nominal = 0.08,
 considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
 For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
 characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.
 with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.03337198
 2 = Asl,com/(b*d)*(fs2/fc) = 0.05950845
 v = Asl,mid/(b*d)*(fsv/fc) = 0.01890095
 and confined core properties:
 b = 340.00
 d = 597.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.00
 cc (5A.5, TBDY) = 0.002
 c = confinement factor = 1.00

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.04123408$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.07352802$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.02335381$$

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

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

$$\text{su (4.9)} = 0.14317227$$

$$\text{Mu} = \text{MRc (4.14)} = 2.1156\text{E}+008$$

$$u = \text{su (4.1)} = 9.5303512\text{E}-006$$

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

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

$$u = 9.8792908\text{E}-006$$

$$\text{Mu} = 3.6117\text{E}+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.00514506$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.00514506$$

$$\phi_{we} \text{ (5.4c)} = 0.00169139$$

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

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\phi_{psh,min}*F_{ywe} = \text{Min}(\phi_{psh,x}*F_{ywe}, \phi_{psh,y}*F_{ywe}) = 1.25908$$

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

$$\phi_{psh,x}*F_{ywe} = \phi_{psh1}*F_{ywe1} + \phi_{psh2}*F_{ywe2} = 2.25223$$

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

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

No stirrups, $n_{s_1} = 2.00$

$$h_1 = 670.00$$

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

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

No stirrups, $n_{s_2} = 2.00$

$$h_2 = 500.00$$

$$\phi_{psh,y}*F_{ywe} = \phi_{psh1}*F_{ywe1} + \phi_{psh2}*F_{ywe2} = 1.25908$$

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

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

No stirrups, $n_{s_1} = 2.00$

$$h_1 = 400.00$$

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

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

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

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 694.45$$

$$fce = 33.00$$

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

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

$$y1 = 0.00140044$$

$$sh1 = 0.0044814$$

$$ft1 = 466.8167$$

$$fy1 = 389.0139$$

$$su1 = 0.00512$$

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

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

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

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

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

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

$$\text{with } fs1 = (fs,jacket \cdot Asl,ten,jacket + fs,core \cdot Asl,ten,core) / Asl,ten = 389.0139$$

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

$$y2 = 0.00140044$$

$$sh2 = 0.0044814$$

$$ft2 = 466.8167$$

$$fy2 = 389.0139$$

$$su2 = 0.00512$$

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

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

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

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

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

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

$$\text{with } fs2 = (fs,jacket \cdot Asl,com,jacket + fs,core \cdot Asl,com,core) / Asl,com = 389.0139$$

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

$$yv = 0.00140044$$

$$shv = 0.0044814$$

$$ftv = 466.8167$$

$$fyv = 389.0139$$

$$suv = 0.00512$$

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

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

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

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

considering characteristic value $fsyv = fsv/1.2$, 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.

yv, shv, ftv, fyv , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = (fs,jacket \cdot Asl,mid,jacket + fs,mid \cdot Asl,mid,core) / Asl,mid = 389.0139$$

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

$$1 = Asl,ten / (b \cdot d) \cdot (fs1 / fce) = 0.05950845$$

$$2 = Asl,com / (b \cdot d) \cdot (fs2 / fce) = 0.03337198$$

$$v = Asl,mid / (b \cdot d) \cdot (fsv / fce) = 0.01890095$$

and confined core properties:

$$b = 340.00$$

d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = $Asl_{ten}/(b*d)*(fs1/fc) = 0.07352802$
2 = $Asl_{com}/(b*d)*(fs2/fc) = 0.04123408$
v = $Asl_{mid}/(b*d)*(fsv/fc) = 0.02335381$
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.17343568
Mu = MRc (4.14) = 3.6117E+008
u = su (4.1) = 9.8792908E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 558200.119$

Calculation of Shear Strength at edge 1, $V_{r1} = 558200.119$
 $V_{r1} = V_n$ ((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: $fc' = (fc'_{jacket} * Area_{jacket} + fc'_{core} * Area_{core}) / Area_{section} = 33.00$, but $fc'^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)

pw = $As/(bw*d) = 0.00331157$
As (tension reinf.) = 709.9999
bw = 400.00
d = 536.00
 $V_u*d/Mu < 1 = 1.00$
Mu = 1.0197E+006
Vu = 9840.634

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 349068.643$
 $V_{s1} = 311834.654$ is calculated for jacket, with:

d = 536.00
Av = 157079.633
fy = 555.56
s = 150.00

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

$V_{s2} = 37233.989$ is calculated for jacket, with:

d2 = 400.00
Av = 100530.965
fy = 555.56
s = 300.00

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

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

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, $V_{r2} = 558200.119$

$V_{r2} = V_n$ ((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: $f'_c = (f'_{c_jacket} \cdot Area_jacket + f'_{c_core} \cdot Area_core) / Area_section = 33.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $p_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu_u < 1 = 1.00$
 $\mu_u = 1.0197E+006$
 $V_u = 9840.632$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 349068.643$
 $V_{s1} = 311834.654$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 37233.989$ is calculated for jacket, with:
 $d = 400.00$
 $A_v = 100530.965$
 $f_y = 555.56$
 $s = 300.00$
 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: $V_s + V_f \leq 818179.336$

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

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

Constant Properties

Knowledge Factor, $\phi = 0.85$
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$
Existing Column
New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$
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, $f_s = 1.25 \cdot f_{sm} = 694.45$
Existing Column
New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 694.45$

External Height, $H = 670.00$
External Width, $W = 400.00$
Internal Height, $H = 500.00$
Internal Width, $W = 200.00$
Cover Thickness, $c = 25.00$

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

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = -3.1831679E-014$
EDGE -B-
Shear Force, $V_b = 3.1831679E-014$
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 , $V_e/V_r = 0.26755321$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 102534.798$
with
 $M_{pr1} = \text{Max}(Mu_{1+} , Mu_{1-}) = 1.5380E+008$
 $Mu_{1+} = 1.5380E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
 $Mu_{1-} = 1.5380E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(Mu_{2+} , Mu_{2-}) = 1.5380E+008$
 $Mu_{2+} = 1.5380E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
 $Mu_{2-} = 1.5380E+008$, 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
 $V_1 = -3.1831679E-014$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 3.1831679E-014$, 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:
 $\phi_u = 1.7246351E-005$
 $M_u = 1.5380E+008$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.00028344$
 $N = 2237.255$
 $f_c = 33.00$

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

$$\text{Final value of } c_u = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00514506$$

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

$$\text{From (5.4b), TBDY: } c_u = 0.00514506$$

$$w_e \text{ (5.4c)} = 0.00169139$$

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

$$\text{ase1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\text{psh, min} * \text{Fywe} = \text{Min}(\text{psh, x} * \text{Fywe}, \text{psh, y} * \text{Fywe}) = 1.25908$$

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

$$\text{psh, x} * \text{Fywe} = \text{psh1} * \text{Fywe1} + \text{ps2} * \text{Fywe2} = 2.25223$$

$$\text{ps1 (external)} = (\text{Ash1} * h_1 / s_1) / \text{Asec} = 0.00261799$$

$$\text{Ash1} = \text{Astir}_1 * \text{ns}_1 = 157.0796$$

No stirrups, ns_1 = 2.00

$$h_1 = 670.00$$

$$\text{ps2 (internal)} = (\text{Ash2} * h_2 / s_2) / \text{Asec} = 0.00062519$$

$$\text{Ash2} = \text{Astir}_2 * \text{ns}_2 = 100.531$$

No stirrups, ns_2 = 2.00

$$h_2 = 500.00$$

$$\text{psh, y} * \text{Fywe} = \text{psh1} * \text{Fywe1} + \text{ps2} * \text{Fywe2} = 1.25908$$

$$\text{ps1 (external)} = (\text{Ash1} * h_1 / s_1) / \text{Asec} = 0.00156298$$

$$\text{Ash1} = \text{Astir}_1 * \text{ns}_1 = 157.0796$$

No stirrups, ns_1 = 2.00

$$h_1 = 400.00$$

$$\text{ps2 (internal)} = (\text{Ash2} * h_2 / s_2) / \text{Asec} = 0.00025008$$

$$\text{Ash2} = \text{Astir}_2 * \text{ns}_2 = 100.531$$

No stirrups, ns_2 = 2.00

$$h_2 = 200.00$$

$$\text{Asec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$\text{fywe1} = 694.45$$

$$\text{fywe2} = 694.45$$

$$\text{fce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

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

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

$$su_1 = 0.4 * \text{esu1_nominal} \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } \text{esu1_nominal} = 0.08,$$

For calculation of esu1_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.

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

$$\text{with } fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 389.0139$$

$$\text{with } E_{s1} = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$$

$$y_2 = 0.00140044$$

$$sh_2 = 0.0044814$$

$$ft_2 = 466.8167$$

$$fy_2 = 389.0139$$

$$su_2 = 0.00512$$

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

$$l_o/l_{o,u,min} = l_b/l_{b,min} = 0.30$$

$$s_u2 = 0.4 * e_{s_u2,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{s_u2,nominal} = 0.08$,

For calculation of $e_{s_u2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $f_{s_y2} = f_{s_2}/1.2$, from table 5.1, TBDY.

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

$$\text{with } f_{s_2} = (f_{s,jacket} * A_{s_l,com,jacket} + f_{s,core} * A_{s_l,com,core}) / A_{s_l,com} = 389.0139$$

$$\text{with } E_{s_2} = (E_{s,jacket} * A_{s_l,com,jacket} + E_{s,core} * A_{s_l,com,core}) / A_{s_l,com} = 200000.00$$

$$y_v = 0.00140044$$

$$sh_v = 0.0044814$$

$$ft_v = 466.8167$$

$$fy_v = 389.0139$$

$$s_{u_v} = 0.00512$$

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

$$l_o/l_{o,u,min} = l_b/l_d = 0.30$$

$$s_{u_v} = 0.4 * e_{s_{u_v},nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{s_{u_v},nominal} = 0.08$,

considering characteristic value $f_{s_{y_v}} = f_{s_v}/1.2$, from table 5.1, TBDY

For calculation of $e_{s_{u_v},nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
characteristic value $f_{s_{y_v}} = f_{s_v}/1.2$, from table 5.1, TBDY.

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

$$\text{with } f_{s_v} = (f_{s,jacket} * A_{s_l,mid,jacket} + f_{s,mid} * A_{s_l,mid,core}) / A_{s_l,mid} = 389.0139$$

$$\text{with } E_{s_v} = (E_{s,jacket} * A_{s_l,mid,jacket} + E_{s,mid} * A_{s_l,mid,core}) / A_{s_l,mid} = 200000.00$$

$$1 = A_{s_l,ten} / (b * d) * (f_{s_1} / f_c) = 0.04490101$$

$$2 = A_{s_l,com} / (b * d) * (f_{s_2} / f_c) = 0.04490101$$

$$v = A_{s_l,mid} / (b * d) * (f_{s_v} / f_c) = 0.0274051$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

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

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

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

$$1 = A_{s_l,ten} / (b * d) * (f_{s_1} / f_c) = 0.05384204$$

$$2 = A_{s_l,com} / (b * d) * (f_{s_2} / f_c) = 0.05384204$$

$$v = A_{s_l,mid} / (b * d) * (f_{s_v} / f_c) = 0.03286221$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.16841906$$

$$\mu_u = M_{Rc} (4.14) = 1.5380E+008$$

$$u = s_u (4.1) = 1.7246351E-005$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_{u1} -

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

$$u = 1.7246351E-005$$

$$\mu_u = 1.5380E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00514506$$

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

$$\text{From (5.4b), TBDY: } c_u = 0.00514506$$

$$w_e (5.4c) = 0.00169139$$

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

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$$

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

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.25223$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.25908$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

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

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

$$su_1 = 0.4 * esu_{1, \text{nominal}} ((5.5), TBDY) = 0.032$$

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

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.

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

$$\text{with } fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 389.0139$$

$$\text{with } Es_1 = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$$

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512

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

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

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

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

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

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

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139

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

yv = 0.00140044
shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

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

lo/lou,min = lb/ld = 0.30

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

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

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

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

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

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

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.04490101

2 = Asl,com/(b*d)*(fs2/fc) = 0.04490101

v = Asl,mid/(b*d)*(fsv/fc) = 0.0274051

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 33.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.05384204

2 = Asl,com/(b*d)*(fs2/fc) = 0.05384204

v = Asl,mid/(b*d)*(fsv/fc) = 0.03286221

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.16841906

Mu = MRc (4.14) = 1.5380E+008

u = su (4.1) = 1.7246351E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

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

u = 1.7246351E-005
Mu = 1.5380E+008

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: $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00514506$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $cu = 0.00514506$
we (5.4c) = 0.00169139
ase ((5.4d), TBDY) = $(ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = $\text{Max}(ase1, ase2) = 0.14776895$
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = $\text{Min}(psh,x * Fywe, psh,y * Fywe) = 1.25908$
Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh_x*Fywe = $psh1 * Fywe1 + ps2 * Fywe2 = 2.25223$
ps1 (external) = $(Ash1 * h1 / s1) / A_{sec} = 0.00261799$
Ash1 = $A_{stir_1} * ns_1 = 157.0796$
No stirrups, 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 stirrups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = $psh1 * Fywe1 + ps2 * Fywe2 = 1.25908$
ps1 (external) = $(Ash1 * h1 / s1) / A_{sec} = 0.00156298$
Ash1 = $A_{stir_1} * ns_1 = 157.0796$
No stirrups, 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 stirrups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00

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

y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = $lb/d = 0.30$
su1 = $0.4 * esu1_nominal$ ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,

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

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

with $fs1 = (fs_{jacket} \cdot Asl_{ten,jacket} + fs_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 389.0139$

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

$y2 = 0.00140044$

$sh2 = 0.0044814$

$ft2 = 466.8167$

$fy2 = 389.0139$

$su2 = 0.00512$

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

$lo/lo_{ou,min} = lb/lb_{,min} = 0.30$

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

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

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

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

with $fs2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 389.0139$

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

$yv = 0.00140044$

$shv = 0.0044814$

$ftv = 466.8167$

$fyv = 389.0139$

$suv = 0.00512$

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

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

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

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

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

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

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

with $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 389.0139$

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

$1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.04490101$

$2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.04490101$

$v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.0274051$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

$fcc (5A.2, TBDY) = 33.00$

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

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

$1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.05384204$

$2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.05384204$

$v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.03286221$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < vs_{y2}$ - LHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.16841906$

$Mu = MRc (4.14) = 1.5380E+008$

$u = su (4.1) = 1.7246351E-005$

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Mu2-

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

$$u = 1.7246351E-005$$

$$\mu = 1.5380E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00514506$$

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

$$\text{From (5.4b), TBDY: } c_u = 0.00514506$$

$$w_e \text{ (5.4c)} = 0.00169139$$

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

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$$

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

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25223$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25908$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/d = 0.30

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

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139

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

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

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

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

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

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

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

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139

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

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/d = 0.30

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

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

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

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

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

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

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.04490101

2 = Asl,com/(b*d)*(fs2/fc) = 0.04490101

v = Asl,mid/(b*d)*(fsv/fc) = 0.0274051

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 33.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.05384204

2 = Asl,com/(b*d)*(fs2/fc) = 0.05384204

v = Asl,mid/(b*d)*(fsv/fc) = 0.03286221

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.16841906

Mu = MRc (4.14) = 1.5380E+008

u = su (4.1) = 1.7246351E-005

Calculation of ratio lb/d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 383231.42$

Calculation of Shear Strength at edge 1, $V_{r1} = 383231.42$
 $V_{r1} = V_n$ ((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
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / \mu_u < 1 = 0.00$
 $\mu_u = 5.3381491E-011$
 $V_u = 3.1831679E-014$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 186169.943$
 $V_{s1} = 186169.943$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$
 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:
 $d_2 = 160.00$
 $A_v = 100530.965$
 $f_y = 555.56$
 $s = 300.00$
 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, $V_{r2} = 383231.42$
 $V_{r2} = V_n$ ((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
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / \mu_u < 1 = 0.00$
 $\mu_u = 4.2118567E-011$
 $V_u = 3.1831679E-014$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 186169.943$
 $V_{s1} = 186169.943$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$
 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:
 $d = 160.00$

Av = 100530.965

fy = 555.56

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, $\phi = 0.85$

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

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

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

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, $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_b/l_d = 0.30$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 6.8007E+006$

Shear Force, $V_2 = -5.4482097E-014$

Shear Force, $V_3 = 4020.305$

Axial Force, $F = -3615.022$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 709.9999$

-Compression: $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

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

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

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

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

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

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

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

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{s,ten,core} = 307.8761$

-Compression: $A_{s,com,core} = 461.8141$

-Middle: $A_{s,mid,core} = 0.00$

Mean Diameter of Tension Reinforcement, $D_bL = 15.00$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_{,R} = 1.0^*$ $u = 0.01106702$

$u = y + p = 0.01106702$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00106702$ ((4.29), Biskinis Phd)

$M_y = 1.5367E+008$

$L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 1691.595

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 -

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

$y_{ten} = 3.0458651E-006$

with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b / d)^{2/3}) = 311.2112$

$d = 627.00$

$y = 0.18520765$

$A = 0.00952871$

$B = 0.00408012$

with $p_t = 0.00283094$

$p_c = 0.00504809$

$p_v = 0.00160336$

$N = 3615.022$

$b = 400.00$

" = 0.06858054

$y_{comp} = 1.9040135E-005$

with $f_c = 33.00$

$E_c = 26999.444$

$y = 0.18428672$

$A = 0.00944964$

$B = 0.0040338$

with $E_s = 200000.00$

Calculation of ratio l_b / d

Inadequate Lap Length with $l_b / d = 0.30$

- Calculation of p -

From table 10-7: $p = 0.01$

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 $V_p / V_o = 0.44897845$

- Transverse Reinforcement: C

- Stirrup Spacing $\leq d / 3$

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

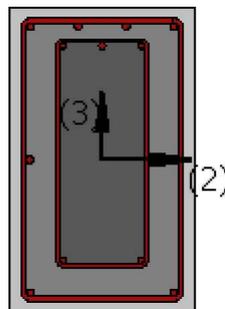
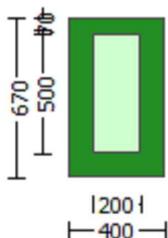
= 4.7228267E-005

- Stirrup Spacing $\leq d/2$
 $d = d_{\text{external}} = 627.00$
 $s = s_{\text{external}} = 150.00$
- Strength provided by hoops $V_s < 3/4 \cdot \text{design Shear}$
 $V_s = 386302.632$, already given in calculation of shear control ratio
design Shear = 4020.305
- $(-) / \text{bal} = -0.22420649$
 $= A_{st}/(b_w \cdot d) = 0.00283094$
Tension Reinf Area: $A_{st} = 709.9999$
 $' = A_{sc}/(b_w \cdot d) = 0.00665146$
Compression Reinf Area: $A_{sc} = 1668.186$
- From (B-1), ACI 318-11: $\text{bal} = 0.01704017$
 $f_c = (f_{c_jacket} \cdot \text{Area}_{\text{jacket}} + f_{c_core} \cdot \text{Area}_{\text{core}}) / \text{section_area} = 33.00$
 $f_y = f_{y_jacket_bars} = 555.56$
From 10.2.7.3, ACI 318-11: $\beta = 0.65$
From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + y) = 0.51922877$
 $y = 0.0027778$
- $V / (b_w \cdot d \cdot f_c^{0.5}) = 0.03360452$, 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: Immediate Occupancy (data interpolation between analysis steps 1 and 2)
- Analysis: Uniform +X
- Check: Shear capacity V_{Rd}
- Edge: Start
- Local Axis: (3)



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

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.85$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$

New material of Primary 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 Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$

New material of Primary 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, $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 6.8007E+006$

Shear Force, $V_a = 4020.305$

EDGE -B-

Bending Moment, $M_b = 1.0660E+007$

Shear Force, $V_b = 15660.961$

BOTH EDGES

Axial Force, $F = -3615.022$

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: $A_{s,ten} = 709.9999$

-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 $V_R = 1.0 \cdot V_n = 489503.773$

V_n ((22.5.1.1), ACI 318-14) = 489503.773

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: $V_c = 175344.508$

= 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)

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

A_s (tension reinf.) = 709.9999

b_w = 400.00

d = 536.00

$V_u*d/M_u < 1 = 0.31686066$

$M_u = 6.8007E+006$

$V_u = 4020.305$

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

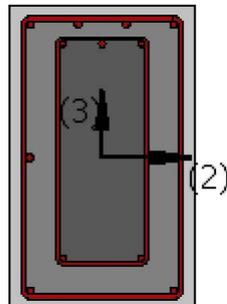
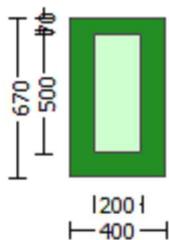
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (μ)

Edge: Start

Local Axis: (3)



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

At Shear local axis: 3

(Bending local axis: 2)
Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.85$
Mean strength values are used for both shear and moment calculations.
Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$
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, $f_s = 1.25 \cdot f_{sm} = 694.45$

Existing Column

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 694.45$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 9840.634$

EDGE -B-

Shear Force, $V_b = 9840.632$

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, $V_e/V_r = 0.44897845$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 250619.824$
with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 3.6117E+008$

$\mu_{1+} = 2.1156E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$\mu_{1-} = 3.6117E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

$M_{pr2} = \max(\mu_{2+}, \mu_{2-}) = 3.6117E+008$

$\mu_{2+} = 2.1156E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

$\mu_{2-} = 3.6117E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

and

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

with

$V_1 = 9840.634$, is the shear force acting at edge 1 for the the static loading combination

$V_2 = 9840.632$, is the shear force acting at edge 2 for the the static loading combination

Calculation of μ_{1+}

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

$\phi_u = 9.5303512E-006$

$\mu = 2.1156E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.00027032$

$N = 2237.255$

$f_c = 33.00$

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

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \max(\phi_u, \phi_c) = 0.00514506$

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

From (5.4b), TBDY: $\phi_u = 0.00514506$

$w_e (5.4c) = 0.00169139$

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

$a_{se1} = 0.14776895$

$b_{o1} = 340.00$

$h_{o1} = 610.00$

$b_{i21} = 975400.00$

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

$b_{o2} = 192.00$

$h_{o2} = 492.00$

$b_{i22} = 557856.00$

$p_{sh, \min} \cdot F_{ywe} = \min(p_{sh, x} \cdot F_{ywe}, p_{sh, y} \cdot F_{ywe}) = 1.25908$

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

 $p_{sh, x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{sh2} \cdot F_{ywe2} = 2.25223$

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

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

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

$h_1 = 670.00$

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

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

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

$h_2 = 500.00$

$p_{sh, y} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{sh2} \cdot F_{ywe2} = 1.25908$

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

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

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

$h_1 = 400.00$

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

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

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

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

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

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

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

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

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

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139

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

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

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

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

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

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

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

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

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139

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

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

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

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

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

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

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

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

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

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.03337198

2 = Asl,com/(b*d)*(fs2/fc) = 0.05950845

v = Asl,mid/(b*d)*(fsv/fc) = 0.01890095

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 33.00

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

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

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.04123408$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.07352802$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.02335381$$

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

--->

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

--->

$$su \text{ (4.9)} = 0.14317227$$

$$\mu_u = MR_c \text{ (4.14)} = 2.1156E+008$$

$$u = su \text{ (4.1)} = 9.5303512E-006$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_{u1} -

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

$$u = 9.8792908E-006$$

$$\mu_u = 3.6117E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00514506$$

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

$$\text{From (5.4b), TBDY: } cu = 0.00514506$$

$$w_e \text{ (5.4c)} = 0.00169139$$

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

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

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

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

$$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.25908$$

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

$$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25223$$

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

$$A_{sh1} = A_{stir_1} * ns_1 = 157.0796$$

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

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (A_{sh2} * h2 / s2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * ns_2 = 100.531$$

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

$$h2 = 500.00$$

$$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25908$$

$$ps1 \text{ (external)} = (A_{sh1} * h1 / s1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * ns_1 = 157.0796$$

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

 $Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 694.45$
 $fywe2 = 694.45$
 $fce = 33.00$

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

$y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 466.8167$
 $fy1 = 389.0139$
 $su1 = 0.00512$

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

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

$su1 = 0.4 \cdot esu1_nominal$ ((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 $fs1 = (fs,jacket \cdot Asl,ten,jacket + fs,core \cdot Asl,ten,core) / Asl,ten = 389.0139$

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

$y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 466.8167$
 $fy2 = 389.0139$
 $su2 = 0.00512$

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

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

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

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

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

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

with $fs2 = (fs,jacket \cdot Asl,com,jacket + fs,core \cdot Asl,com,core) / Asl,com = 389.0139$

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

$yv = 0.00140044$
 $shv = 0.0044814$
 $ftv = 466.8167$
 $fyv = 389.0139$
 $suv = 0.00512$

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

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

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

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

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

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

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

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

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

$1 = Asl,ten / (b \cdot d) \cdot (fs1 / fc) = 0.05950845$
 $2 = Asl,com / (b \cdot d) \cdot (fs2 / fc) = 0.03337198$
 $v = Asl,mid / (b \cdot d) \cdot (fsv / fc) = 0.01890095$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 33.00$$

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

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

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.07352802$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.04123408$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.02335381$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$s_u (4.9) = 0.17343568$$

$$M_u = M_{Rc} (4.14) = 3.6117E+008$$

$$u = s_u (4.1) = 9.8792908E-006$$

Calculation of ratio l_b/d

Inadequate Lap Length with $l_b/d = 0.30$

Calculation of M_{u2+}

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

$$u = 9.5303512E-006$$

$$M_u = 2.1156E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00514506$$

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

$$\text{From (5.4b), TBDY: } c_u = 0.00514506$$

$$w_e (5.4c) = 0.00169139$$

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

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh,min}*F_{ywe} = \text{Min}(p_{sh,x}*F_{ywe}, p_{sh,y}*F_{ywe}) = 1.25908$$

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

$$p_{sh,x}*F_{ywe} = p_{sh1}*F_{ywe1} + p_{sh2}*F_{ywe2} = 2.25223$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h2 = 500.00$$

$$\begin{aligned} psh_y * Fywe &= psh1 * Fywe1 + ps2 * Fywe2 = 1.25908 \\ ps1 \text{ (external)} &= (Ash1 * h1 / s1) / Asec = 0.00156298 \\ Ash1 &= Astir_1 * ns_1 = 157.0796 \\ \text{No stirups, } ns_1 &= 2.00 \\ h1 &= 400.00 \\ ps2 \text{ (internal)} &= (Ash2 * h2 / s2) / Asec = 0.00025008 \\ Ash2 &= Astir_2 * ns_2 = 100.531 \\ \text{No stirups, } ns_2 &= 2.00 \\ h2 &= 200.00 \end{aligned}$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 694.45$$

$$fce = 33.00$$

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

$c =$ confinement factor = 1.00

$$y1 = 0.00140044$$

$$sh1 = 0.0044814$$

$$ft1 = 466.8167$$

$$fy1 = 389.0139$$

$$su1 = 0.00512$$

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

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

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

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

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

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

$$\text{with } fs1 = (fs_jacket * Asl, \text{ten, jacket} + fs_core * Asl, \text{ten, core}) / Asl, \text{ten} = 389.0139$$

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

$$y2 = 0.00140044$$

$$sh2 = 0.0044814$$

$$ft2 = 466.8167$$

$$fy2 = 389.0139$$

$$su2 = 0.00512$$

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

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

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

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

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

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

$$\text{with } fs2 = (fs_jacket * Asl, \text{com, jacket} + fs_core * Asl, \text{com, core}) / Asl, \text{com} = 389.0139$$

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

$$yv = 0.00140044$$

$$shv = 0.0044814$$

$$ftv = 466.8167$$

$$fyv = 389.0139$$

$$suv = 0.00512$$

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

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

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

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 $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 389.0139$
 with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.03337198$
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.05950845$
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.01890095$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.04123408$
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.07352802$
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02335381$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$\mu (4.9) = 0.14317227$
 $\mu = M_{Rc} (4.14) = 2.1156E+008$
 $u = \mu (4.1) = 9.5303512E-006$

 Calculation of ratio l_b / l_d

 Inadequate Lap Length with $l_b / l_d = 0.30$

 Calculation of μ_2 -

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

$u = 9.8792908E-006$
 $\mu = 3.6117E+008$

 with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00027032$
 $N = 2237.255$
 $f_c = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 Final value of c_u : $c_u^* = \text{shear_factor} \cdot \text{Max}(c_u, cc) = 0.00514506$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.00514506$
 $w_e (5.4c) = 0.00169139$
 $ase ((5.4d), TBDY) = (ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$
 $p_{sh,min} \cdot F_{ywe} = \text{Min}(p_{sh,x} \cdot F_{ywe}, p_{sh,y} \cdot F_{ywe}) = 1.25908$

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

 $p_{sh,x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 2.25223$
 $ps1 (external) = (A_{sh1} \cdot h1 / s1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$

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 = 1.25908
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 = 694.45
fywe₂ = 694.45
fce = 33.00

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

y₁ = 0.00140044
sh₁ = 0.0044814
ft₁ = 466.8167
fy₁ = 389.0139
su₁ = 0.00512

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

lo/lou,min = lb/ld = 0.30

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

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

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

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

with fs₁ = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139

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

y₂ = 0.00140044
sh₂ = 0.0044814
ft₂ = 466.8167
fy₂ = 389.0139
su₂ = 0.00512

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

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

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

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

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

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

with fs₂ = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139

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

y_v = 0.00140044
sh_v = 0.0044814
ft_v = 466.8167
fy_v = 389.0139
su_v = 0.00512

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

lo/lou,min = lb/ld = 0.30

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

From table 5A.1, TBDY: $e_{suv_nominal} = 0.08$,
considering characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY
For calculation of $e_{suv_nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.

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

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

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

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.05950845$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.03337198$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.01890095$

and confined core properties:

$b = 340.00$

$d = 597.00$

$d' = 13.00$

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

cc (5A.5, TBDY) = 0.002

$c =$ confinement factor = 1.00

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.07352802$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.04123408$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02335381$

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

---->

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

---->

su (4.9) = 0.17343568

$Mu = MR_c$ (4.14) = 3.6117E+008

$u = su$ (4.1) = 9.8792908E-006

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 558200.119$

Calculation of Shear Strength at edge 1, $V_{r1} = 558200.119$

$V_{r1} = V_n$ ((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: $V_c = 209131.476$

= 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)

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

A_s (tension reinf.) = 709.9999

$b_w = 400.00$

$d = 536.00$

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

$Mu = 1.0197E+006$

$V_u = 9840.634$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 349068.643$

$V_{s1} = 311834.654$ is calculated for jacket, with:

$d = 536.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 150.00$

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

$V_{s2} = 37233.989$ is calculated for jacket, with:

$d_2 = 400.00$

$A_v = 100530.965$

$f_y = 555.56$

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

Calculation of Shear Strength at edge 2, Vr2 = 558200.119

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 = 9840.632

From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 349068.643

Vs1 = 311834.654 is calculated for jacket, with:

d = 536.00

Av = 157079.633

fy = 555.56

s = 150.00

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

Vs2 = 37233.989 is calculated for jacket, with:

d = 400.00

Av = 100530.965

fy = 555.56

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, = 0.85

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

Consequently:

Jacket

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

New material of Primary Member: Steel Strength, fs = fsm = 555.56

Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00

Existing Column

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

New material of Primary Member: Steel Strength, fs = fsm = 555.56

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

Existing Column

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 694.45$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = -3.1831679E-014$

EDGE -B-

Shear Force, $V_b = 3.1831679E-014$

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: $As_{t,ten} = 911.0619$

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

-Middle: $As_{l,mid} = 556.0619$

Calculation of Shear Capacity ratio , $V_e/V_r = 0.26755321$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n / 2 = 102534.798$
with

$M_{pr1} = \text{Max}(Mu_{1+} , Mu_{1-}) = 1.5380E+008$

$Mu_{1+} = 1.5380E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination

$Mu_{1-} = 1.5380E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination

$M_{pr2} = \text{Max}(Mu_{2+} , Mu_{2-}) = 1.5380E+008$

$Mu_{2+} = 1.5380E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination

$Mu_{2-} = 1.5380E+008$, 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

$V_1 = -3.1831679E-014$, is the shear force acting at edge 1 for the the static loading combination

$V_2 = 3.1831679E-014$, 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:

$$u = 1.7246351E-005$$

$$Mu = 1.5380E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.00514506$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.00514506$$

$$w_e(5.4c) = 0.00169139$$

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

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.25908$$

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

$$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25223$$

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

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

No stirrups, $n_{s_1} = 2.00$

$$h_1 = 670.00$$

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

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

No stirrups, $n_{s_2} = 2.00$

$$h_2 = 500.00$$

$$p_{sh,y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25908$$

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

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

No stirrups, $n_{s_1} = 2.00$

$$h_1 = 400.00$$

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

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

No stirrups, $n_{s_2} = 2.00$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

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

and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

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

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

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

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

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

$$\text{with } fs1 = (fs_jacket * Asl,ten,jacket + fs_core * Asl,ten,core) / Asl,ten = 389.0139$$

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

$$y2 = 0.00140044$$

$$sh2 = 0.0044814$$

$$ft2 = 466.8167$$

$$fy2 = 389.0139$$

$$su2 = 0.00512$$

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

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

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

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

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

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

$$\text{with } fs2 = (fs_jacket * Asl,com,jacket + fs_core * Asl,com,core) / Asl,com = 389.0139$$

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

$$yv = 0.00140044$$

$$shv = 0.0044814$$

$$ftv = 466.8167$$

$$fyv = 389.0139$$

$$suv = 0.00512$$

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

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

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

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

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

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

yv, shv, ftv, fyv , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = (fs_jacket * Asl,mid,jacket + fs_mid * Asl,mid,core) / Asl,mid = 389.0139$$

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

$$1 = Asl,ten / (b * d) * (fs1 / fc) = 0.04490101$$

$$2 = Asl,com / (b * d) * (fs2 / fc) = 0.04490101$$

$$v = Asl,mid / (b * d) * (fsv / fc) = 0.0274051$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 33.00$$

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

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

$$1 = Asl,ten / (b * d) * (fs1 / fc) = 0.05384204$$

$$2 = Asl,com / (b * d) * (fs2 / fc) = 0.05384204$$

$$v = Asl,mid / (b * d) * (fsv / fc) = 0.03286221$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$su (4.9) = 0.16841906$$

$$Mu = MRc (4.14) = 1.5380E+008$$

$$u = su (4.1) = 1.7246351E-005$$

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Mu1-

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

$$\mu = 1.7246351E-005$$

$$Mu = 1.5380E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu, cc) = 0.00514506$$

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

$$\text{From (5.4b), TBDY: } \mu = 0.00514506$$

$$w_e \text{ (5.4c)} = 0.00169139$$

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

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

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

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

$$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.25908$$

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

$$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25223$$

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

$$A_{sh1} = A_{stir_1} * ns_1 = 157.0796$$

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

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (A_{sh2} * h2 / s2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * ns_2 = 100.531$$

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

$$h2 = 500.00$$

$$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25908$$

$$ps1 \text{ (external)} = (A_{sh1} * h1 / s1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * ns_1 = 157.0796$$

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

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (A_{sh2} * h2 / s2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * ns_2 = 100.531$$

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

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y1 = 0.00140044$$

$$sh1 = 0.0044814$$

$$ft1 = 466.8167$$

$$fy1 = 389.0139$$

su1 = 0.00512

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

lo/lou,min = lb/ld = 0.30

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

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139

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

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

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

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

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

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

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

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

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139

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

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

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

lo/lou,min = lb/ld = 0.30

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

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

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

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

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

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.04490101

2 = Asl,com/(b*d)*(fs2/fc) = 0.04490101

v = Asl,mid/(b*d)*(fsv/fc) = 0.0274051

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 33.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.05384204

2 = Asl,com/(b*d)*(fs2/fc) = 0.05384204

v = Asl,mid/(b*d)*(fsv/fc) = 0.03286221

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.16841906

Mu = MRc (4.14) = 1.5380E+008

u = su (4.1) = 1.7246351E-005

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_{2+}

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

$$\mu = 1.7246351E-005$$

$$\mu_{2+} = 1.5380E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu_{cu}: \mu_{cu}^* = \text{shear_factor} * \text{Max}(\mu_{cu}, \mu_{cc}) = 0.00514506$$

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

$$\text{From (5.4b), TBDY: } \mu_{cu} = 0.00514506$$

$$\mu_{we} \text{ (5.4c)} = 0.00169139$$

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

$$\mu_{ase1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\mu_{psh,min} * F_{ywe} = \text{Min}(\mu_{psh,x} * F_{ywe}, \mu_{psh,y} * F_{ywe}) = 1.25908$$

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

$$\mu_{psh,x} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{psh2} * F_{ywe2} = 2.25223$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$\mu_{psh,y} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{psh2} * F_{ywe2} = 1.25908$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_c = 33.00$$

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

$c = \text{confinement factor} = 1.00$
 $y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 466.8167$
 $fy1 = 389.0139$
 $su1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/ld = 0.30$
 $su1 = 0.4 * esu1_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu1_nominal = 0.08$,
 For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = (fs,jacket * Asl,ten,jacket + fs,core * Asl,ten,core) / Asl,ten = 389.0139$
 with $Es1 = (Es,jacket * Asl,ten,jacket + Es,core * Asl,ten,core) / Asl,ten = 200000.00$
 $y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 466.8167$
 $fy2 = 389.0139$
 $su2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/lb,min = 0.30$
 $su2 = 0.4 * esu2_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = (fs,jacket * Asl,com,jacket + fs,core * Asl,com,core) / Asl,com = 389.0139$
 with $Es2 = (Es,jacket * Asl,com,jacket + Es,core * Asl,com,core) / Asl,com = 200000.00$
 $yv = 0.00140044$
 $shv = 0.0044814$
 $ftv = 466.8167$
 $fyv = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/ld = 0.30$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs,jacket * Asl,mid,jacket + fs,mid * Asl,mid,core) / Asl,mid = 389.0139$
 with $Es_v = (Es,jacket * Asl,mid,jacket + Es,mid * Asl,mid,core) / Asl,mid = 200000.00$
 $1 = Asl,ten / (b * d) * (fs1 / fc) = 0.04490101$
 $2 = Asl,com / (b * d) * (fs2 / fc) = 0.04490101$
 $v = Asl,mid / (b * d) * (fsv / fc) = 0.0274051$
 and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl,ten / (b * d) * (fs1 / fc) = 0.05384204$
 $2 = Asl,com / (b * d) * (fs2 / fc) = 0.05384204$
 $v = Asl,mid / (b * d) * (fsv / fc) = 0.03286221$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.16841906
Mu = MRc (4.14) = 1.5380E+008
u = su (4.1) = 1.7246351E-005

Calculation of ratio lb/l_d

Inadequate Lap Length with lb/l_d = 0.30

Calculation of Mu₂-

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

u = 1.7246351E-005
Mu = 1.5380E+008

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 ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.00514506$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\phi_u = 0.00514506$
w_e (5.4c) = 0.00169139
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_{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
psh,min*F_{ywe} = $\text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.25908$
Expression ((5.4d), TBDY) for psh,min*F_{ywe} has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh_x*F_{ywe} = psh₁*F_{ywe1} + ps₂*F_{ywe2} = 2.25223
ps₁ (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$
A_{sh1} = A_{stir_1} * ns₁ = 157.0796
No stirrups, ns₁ = 2.00
h₁ = 670.00
ps₂ (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$
A_{sh2} = A_{stir_2} * ns₂ = 100.531
No stirrups, ns₂ = 2.00
h₂ = 500.00

psh_y*F_{ywe} = psh₁*F_{ywe1} + ps₂*F_{ywe2} = 1.25908
ps₁ (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$
A_{sh1} = A_{stir_1} * ns₁ = 157.0796
No stirrups, ns₁ = 2.00
h₁ = 400.00
ps₂ (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$
A_{sh2} = A_{stir_2} * ns₂ = 100.531
No stirrups, ns₂ = 2.00
h₂ = 200.00

A_{sec} = 268000.00
s₁ = 150.00

$s_2 = 300.00$
 $fy_{we1} = 694.45$
 $fy_{we2} = 694.45$
 $f_{ce} = 33.00$
 From ((5.A.5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y_1 = 0.00140044$
 $sh_1 = 0.0044814$
 $ft_1 = 466.8167$
 $fy_1 = 389.0139$
 $su_1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/d = 0.30$
 $su_1 = 0.4 * esu_1_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_1_nominal = 0.08$,
 For calculation of $esu_1_nominal$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = (fs_{jacket} * Asl, ten, jacket + fs_{core} * Asl, ten, core) / Asl, ten = 389.0139$
 with $Es_1 = (Es_{jacket} * Asl, ten, jacket + Es_{core} * Asl, ten, core) / Asl, ten = 200000.00$
 $y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 466.8167$
 $fy_2 = 389.0139$
 $su_2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/lb, min = 0.30$
 $su_2 = 0.4 * esu_2_nominal ((5.5), TBDY) = 0.032$
 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 $Min(1, 1.25 * (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} * Asl, com, jacket + fs_{core} * Asl, com, core) / Asl, com = 389.0139$
 with $Es_2 = (Es_{jacket} * Asl, com, jacket + Es_{core} * Asl, com, core) / Asl, com = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/d = 0.30$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = (fs_{jacket} * Asl, mid, jacket + fs_{mid} * Asl, mid, core) / Asl, mid = 389.0139$
 with $Es_v = (Es_{jacket} * Asl, mid, jacket + Es_{mid} * Asl, mid, core) / Asl, mid = 200000.00$
 $1 = Asl, ten / (b * d) * (fs_1 / f_c) = 0.04490101$
 $2 = Asl, com / (b * d) * (fs_2 / f_c) = 0.04490101$
 $v = Asl, mid / (b * d) * (fs_v / f_c) = 0.0274051$
 and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl, ten / (b * d) * (fs_1 / f_c) = 0.05384204$
 $2 = Asl, com / (b * d) * (fs_2 / f_c) = 0.05384204$

$$v = A_{sl, mid} / (b * d) * (f_{sv} / f_c) = 0.03286221$$

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

--->

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

--->

$$s_u(4.9) = 0.16841906$$

$$\mu = M_{Rc}(4.14) = 1.5380E+008$$

$$u = s_u(4.1) = 1.7246351E-005$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 383231.42$

Calculation of Shear Strength at edge 1, $V_{r1} = 383231.42$

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

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

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

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

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

$$b_w = 670.00$$

$$d = 320.00$$

$$V_u * d / \mu < 1 = 0.00$$

$$\mu = 5.3381491E-011$$

$$V_u = 3.1831679E-014$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 186169.943$

$V_{s1} = 186169.943$ is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

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:

$$d_2 = 160.00$$

$$A_v = 100530.965$$

$$f_y = 555.56$$

$$s = 300.00$$

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

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

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

Calculation of Shear Strength at edge 2, $V_{r2} = 383231.42$

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

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

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

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

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

$$b_w = 670.00$$

$$d = 320.00$$

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

$$\mu_u = 4.2118567E-011$$

$$V_u = 3.1831679E-014$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 186169.943$

$V_{s1} = 186169.943$ is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

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:

$$d = 160.00$$

$$A_v = 100530.965$$

$$f_y = 555.56$$

$$s = 300.00$$

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

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

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

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, $\phi = 0.85$

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

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

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

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, $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_b / l_d = 0.30$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = -1.1740586E-010$

Shear Force, $V_2 = -5.4482097E-014$

Shear Force, $V_3 = 4020.305$

Axial Force, $F = -3615.022$

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: $A_{st,mid} = 556.0619$

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{st,ten,jacket} = 603.1858$

-Compression: $A_{sc,com,jacket} = 603.1858$

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

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{st,ten,core} = 307.8761$

-Compression: $A_{sc,com,core} = 307.8761$

-Middle: $A_{st,mid,core} = 153.938$

Mean Diameter of Tension Reinforcement, $DbL = 15.20$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.00693154$

$u = y + p = 0.00693154$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00193154$ ((4.29), Biskinis Phd))

$M_y = 1.1181E+008$

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

From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 2.8943E+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

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

$y_{ten} = 5.6157722E-006$

with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b/d)^{2/3}) = 311.2112$

$d = 357.00$

$y = 0.2238468$

$A = 0.00999123$

$B = 0.00561868$

with $p_t = 0.00380895$

$p_c = 0.00380895$

$p_v = 0.00232477$

$N = 3615.022$

$b = 670.00$

$" = 0.12044818$

$y_{comp} = 2.7622786E-005$

with $f_c = 33.00$

$E_c = 26999.444$

$y = 0.22309812$

$A = 0.00990831$

$B = 0.00557012$

with $E_s = 200000.00$

Calculation of ratio l_b/d

Inadequate Lap Length with $l_b/d = 0.30$

- Calculation of p -

From table 10-7: $p = 0.005$

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 $V_p/V_o = 0.26755321$
- Transverse Reinforcement: NC
- Stirrup Spacing $> d/3$
- Low ductility demand, $\lambda / \gamma < 2$ (table 10-6, ASCE 41-17)
 $= 8.5190903E-022$
- Stirrup Spacing $\leq d/2$
 $d = d_{\text{external}} = 357.00$
 $s = s_{\text{external}} = 150.00$
- Strength provided by hoops $V_s < 3/4 \cdot \text{design Shear}$
 $V_s = 215957.134$, already given in calculation of shear control ratio
design Shear = $5.4482097E-014$
- ($\rho - \rho'_{\text{bal}}$) / $\rho_{\text{bal}} = -0.23508921$
 $\rho = A_{s1}/(b_w \cdot d) = 0.00296835$
Tension Reinf Area: $A_{s1} = 709.9999$
 $\rho' = A_{s2}/(b_w \cdot d) = 0.00697431$
Compression Reinf Area: $A_{s2} = 1668.186$
- From (B-1), ACI 318-11: $\rho_{\text{bal}} = 0.01704017$
 $\rho_c = (\rho_{c,\text{jacket}} \cdot \text{Area}_{\text{jacket}} + \rho_{c,\text{core}} \cdot \text{Area}_{\text{core}}) / \text{section_area} = 33.00$
 $\rho_y = \rho_{y,\text{jacket_bars}} = 555.56$
From 10.2.7.3, ACI 318-11: $\lambda = 0.65$
From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + \rho_y) = c_b/d_t = 0.003 / (0.003 + \rho_y) = 0.51922877$
 $\gamma = 0.0027778$
- $V / (b_w \cdot d \cdot \rho_c^{0.5}) = 4.7750405E-019$, 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

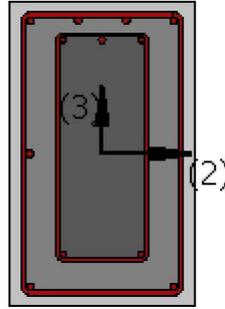
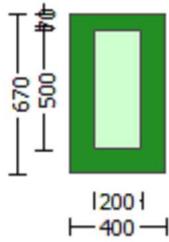
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (2)



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

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.85$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$

New material of Primary 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 Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$

New material of Primary 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, $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = -1.1740586E-010$

Shear Force, $V_a = -5.4482097E-014$

EDGE -B-

Bending Moment, $M_b = -4.6355638E-011$

Shear Force, $V_b = 5.4482097E-014$

BOTH EDGES

Axial Force, $F = -3615.022$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 709.9999$

-Compression: $A_{sc} = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{st,ten} = 911.0619$

-Compression: $A_{st,com} = 911.0619$

-Middle: $As_{l,mid} = 556.0619$

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

$b_w = 670.00$

$d = 320.00$

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

$\mu_u = 4.6355638E-011$

$V_u = 5.4482097E-014$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 167551.608$

$V_{s1} = 167551.608$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 500.00$

$s = 150.00$

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

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

$d = 160.00$

$A_v = 100530.965$

$f_y = 500.00$

$s = 300.00$

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

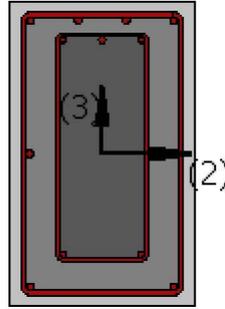
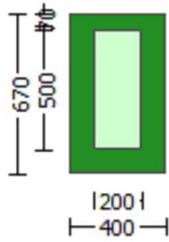
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

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, $\gamma = 0.85$
 Mean strength values are used for both shear and moment calculations.
 Consequently:

Jacket
 New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
 New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$
 Concrete Elasticity, $E_c = 26999.444$
 Steel Elasticity, $E_s = 200000.00$

Existing Column
 New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
 New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$
 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, $f_s = 1.25 \cdot f_{sm} = 694.45$
 Existing Column
 New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 694.45$

#####

External Height, $H = 670.00$
 External Width, $W = 400.00$
 Internal Height, $H = 500.00$
 Internal Width, $W = 200.00$
 Cover Thickness, $c = 25.00$
 Mean Confinement Factor overall section = 1.00
 Element Length, $L = 3000.00$

Primary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Inadequate Lap Length with $l_o/l_{ou, \min} = 0.30$
 No FRP Wrapping

Stepwise Properties

At local axis: 3
 EDGE -A-
 Shear Force, $V_a = 9840.634$
 EDGE -B-
 Shear Force, $V_b = 9840.632$
 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, $V_e/V_r = 0.44897845$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 250619.824$
with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 3.6117E+008$
 $M_{u1+} = 2.1156E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
 $M_{u1-} = 3.6117E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 3.6117E+008$
 $M_{u2+} = 2.1156E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination
 $M_{u2-} = 3.6117E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = 9840.634$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 9840.632$, is the shear force acting at edge 2 for the static loading combination

Calculation of M_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 9.5303512E-006$
 $M_u = 2.1156E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00027032$
 $N = 2237.255$
 $f_c = 33.00$
 $\alpha_1(5A.5, \text{TBDY}) = 0.002$
Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00514506$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\phi_u = 0.00514506$
 $w_e(5.4c) = 0.00169139$
 $a_{se}((5.4d), \text{TBDY}) = (a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int})/A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$
 $\text{psh}_{,min} \cdot F_{ywe} = \text{Min}(\text{psh}_{,x} \cdot F_{ywe}, \text{psh}_{,y} \cdot F_{ywe}) = 1.25908$
Expression ((5.4d), TBDY) for $\text{psh}_{,min} \cdot F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $\text{psh}_{,x} \cdot F_{ywe} = \text{psh}_1 \cdot F_{ywe1} + \text{ps}_2 \cdot F_{ywe2} = 2.25223$

ps1 (external) = $(Ash1 \cdot h1 / s1) / Asec = 0.00261799$
Ash1 = Astir_1 * ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = $(Ash2 \cdot h2 / s2) / Asec = 0.00062519$
Ash2 = Astir_2 * ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.25908
ps1 (external) = $(Ash1 \cdot h1 / s1) / Asec = 0.00156298$
Ash1 = Astir_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 * ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00

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

y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512

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

lo/lou,min = lb/lb = 0.30

su1 = $0.4 \cdot esu1_nominal$ ((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 = $(fs_jacket \cdot Asl,ten,jacket + fs_core \cdot Asl,ten,core) / Asl,ten = 389.0139$

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

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512

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

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

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

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

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

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

with fs2 = $(fs_jacket \cdot Asl,com,jacket + fs_core \cdot Asl,com,core) / Asl,com = 389.0139$

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

yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512

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

$$l_0/l_{ou,min} = l_b/l_d = 0.30$$

$$s_{uv} = 0.4 * e_{suv,nominal} ((5.5), TBDY) = 0.032$$

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

considering characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY

For calculation of $e_{suv,nominal}$ and γ_v , sh_v, ft_v, fy_v , it is considered

characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.

$$\gamma_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b/l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 389.0139$$

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

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.03337198$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.05950845$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.01890095$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

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

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

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

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.04123408$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.07352802$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.02335381$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$s_u (4.9) = 0.14317227$$

$$M_u = M_{Rc} (4.14) = 2.1156E+008$$

$$u = s_u (4.1) = 9.5303512E-006$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of M_{u1} -

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

$$u = 9.8792908E-006$$

$$M_u = 3.6117E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00514506$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00514506$$

$$\text{we (5.4c) } = 0.00169139$$

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

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$psh_{min} * Fy_{we} = \text{Min}(psh_x * Fy_{we}, psh_y * Fy_{we}) = 1.25908$$

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

$$psh_x * Fy_{we} = psh_1 * Fy_{we1} + ps_2 * Fy_{we2} = 2.25223$$

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

$$Ash_1 = Astir_1 * ns_1 = 157.0796$$

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

$$h_1 = 670.00$$

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

$$Ash_2 = Astir_2 * ns_2 = 100.531$$

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

$$h_2 = 500.00$$

$$psh_y * Fy_{we} = psh_1 * Fy_{we1} + ps_2 * Fy_{we2} = 1.25908$$

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

$$Ash_1 = Astir_1 * ns_1 = 157.0796$$

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

$$h_1 = 400.00$$

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

$$Ash_2 = Astir_2 * ns_2 = 100.531$$

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$fy_{we1} = 694.45$$

$$fy_{we2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

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

$$lo/lou_{min} = lb/l_d = 0.30$$

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

From table 5A.1, TBDY: $esu_{1_nominal} = 0.08$,

For calculation of $esu_{1_nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.

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

$$\text{with } fs_1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 389.0139$$

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

$$y_2 = 0.00140044$$

$$sh_2 = 0.0044814$$

$$ft_2 = 466.8167$$

$$fy_2 = 389.0139$$

$$su_2 = 0.00512$$

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

$$lo/lou_{min} = lb/l_{b,min} = 0.30$$

$$su_2 = 0.4 * esu_{2_nominal} \text{ ((5.5), TBDY)} = 0.032$$

From table 5A.1, TBDY: $esu_{2_nominal} = 0.08$,

For calculation of $esu_{2_nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered characteristic value $fsy_2 = fs_2 / 1.2$, from table 5.1, TBDY.

y_2, sh_2, ft_2, fy_2 , are also multiplied by $\text{Min}(1, 1.25 * (lb/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 389.0139$$

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

$$y_v = 0.00140044$$

$$sh_v = 0.0044814$$

$$ft_v = 466.8167$$

$f_{yv} = 389.0139$
 $s_{uv} = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $s_{uv} = 0.4 * e_{suv_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $e_{suv_nominal} = 0.08$,
 considering characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $e_{suv_nominal}$ and y_v , sh_v , ft_v , f_{yv} , it is considered
 characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1 , sh_1 , ft_1 , f_{y1} , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 389.0139$
 with $E_{sv} = (E_{s,jacket} * A_{s,mid,jacket} + E_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 200000.00$
 $1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.05950845$
 $2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.03337198$
 $v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.01890095$
 and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.07352802$
 $2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.04123408$
 $v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.02335381$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $s_u (4.9) = 0.17343568$
 $\mu_u = M_{Rc} (4.14) = 3.6117E+008$
 $u = s_u (4.1) = 9.8792908E-006$

 Calculation of ratio l_b/l_d

 Inadequate Lap Length with $l_b/l_d = 0.30$

 Calculation of μ_{u2+}

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

$u = 9.5303512E-006$
 $\mu_u = 2.1156E+008$

 with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00027032$
 $N = 2237.255$
 $f_c = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 Final value of c_u : $c_u^* = \text{shear_factor} * \text{Max}(c_u, cc) = 0.00514506$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.00514506$
 $w_e (5.4c) = 0.00169139$
 $ase ((5.4d), TBDY) = (ase_1 * A_{ext} + ase_2 * A_{int}) / A_{sec} = 0.14776895$
 $ase_1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$

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) = 1.25908

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

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25223
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25908
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00

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

y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512

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

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

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

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139

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

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512

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

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

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

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

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

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

with $f_{s2} = (f_{s,jacket} \cdot A_{s1,com,jacket} + f_{s,core} \cdot A_{s1,com,core}) / A_{s1,com} = 389.0139$
 with $E_{s2} = (E_{s,jacket} \cdot A_{s1,com,jacket} + E_{s,core} \cdot A_{s1,com,core}) / A_{s1,com} = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 389.0139$
 with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$
 $1 = A_{s1,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.03337198$
 $2 = A_{s1,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.05950845$
 $v = A_{s1,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.01890095$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{s1,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.04123408$
 $2 = A_{s1,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.07352802$
 $v = A_{s1,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02335381$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

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

$su (4.9) = 0.14317227$

$Mu = MRc (4.14) = 2.1156E+008$

$u = su (4.1) = 9.5303512E-006$

 Calculation of ratio l_b/l_d

 Inadequate Lap Length with $l_b/l_d = 0.30$

 Calculation of Mu_2 -

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

$u = 9.8792908E-006$

$Mu = 3.6117E+008$

 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 : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.00514506$

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

From (5.4b), TBDY: $cu = 0.00514506$

w_e (5.4c) = 0.00169139
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$

$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$

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

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25223$
 $ps1$ (external) = $(A_{sh1} * h1 / s1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2$ (internal) = $(A_{sh2} * h2 / s2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25908$
 $ps1$ (external) = $(A_{sh1} * h1 / s1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2$ (internal) = $(A_{sh2} * h2 / s2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir_2} * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$A_{sec} = 268000.00$

$s1 = 150.00$

$s2 = 300.00$

$fywe1 = 694.45$

$fywe2 = 694.45$

$f_{ce} = 33.00$

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

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

$y1 = 0.00140044$

$sh1 = 0.0044814$

$ft1 = 466.8167$

$fy1 = 389.0139$

$su1 = 0.00512$

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

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

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

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

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

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

with $fs1 = (fs, \text{jacket} * A_{sl, \text{ten, jacket}} + fs, \text{core} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 389.0139$

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

$y2 = 0.00140044$

$sh2 = 0.0044814$

$ft2 = 466.8167$

$fy2 = 389.0139$

$su2 = 0.00512$

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

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

$$su_2 = 0.4 * esu_{2_nominal} ((5.5), TBDY) = 0.032$$

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

$$\text{with } fs_2 = (fs_{jacket} * Asl_{,com,jacket} + fs_{core} * Asl_{,com,core}) / Asl_{,com} = 389.0139$$

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

$$y_v = 0.00140044$$

$$sh_v = 0.0044814$$

$$ft_v = 466.8167$$

$$fy_v = 389.0139$$

$$suv = 0.00512$$

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

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

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

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

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_{nominal}$ and 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.

$$\text{with } fsv = (fs_{jacket} * Asl_{,mid,jacket} + fs_{mid} * Asl_{,mid,core}) / Asl_{,mid} = 389.0139$$

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

$$1 = Asl_{,ten} / (b * d) * (fs_1 / fc) = 0.05950845$$

$$2 = Asl_{,com} / (b * d) * (fs_2 / fc) = 0.03337198$$

$$v = Asl_{,mid} / (b * d) * (fsv / fc) = 0.01890095$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 33.00$$

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

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

$$1 = Asl_{,ten} / (b * d) * (fs_1 / fc) = 0.07352802$$

$$2 = Asl_{,com} / (b * d) * (fs_2 / fc) = 0.04123408$$

$$v = Asl_{,mid} / (b * d) * (fsv / fc) = 0.02335381$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied

--->

$$su (4.9) = 0.17343568$$

$$Mu = MRc (4.14) = 3.6117E+008$$

$$u = su (4.1) = 9.8792908E-006$$

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 558200.119$

Calculation of Shear Strength at edge 1, $V_{r1} = 558200.119$

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

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).

$$\text{From Table (22.5.5.1), ACI 318-14: } V_c = 209131.476$$

$$= 1 \text{ (normal-weight concrete)}$$

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 (tension reinf.) = 709.9999

bw = 400.00

d = 536.00

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

$\mu = 1.0197E+006$

$V_u = 9840.634$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 349068.643$

$V_{s1} = 311834.654$ is calculated for jacket, with:

d = 536.00

$A_v = 157079.633$

$f_y = 555.56$

s = 150.00

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

$V_{s2} = 37233.989$ is calculated for jacket, with:

d2 = 400.00

$A_v = 100530.965$

$f_y = 555.56$

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, $V_{r2} = 558200.119$

$V_{r2} = V_n$ ((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: $V_c = 209131.476$

= 1 (normal-weight concrete)

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

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

As (tension reinf.) = 709.9999

bw = 400.00

d = 536.00

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

$\mu = 1.0197E+006$

$V_u = 9840.632$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 349068.643$

$V_{s1} = 311834.654$ is calculated for jacket, with:

d = 536.00

$A_v = 157079.633$

$f_y = 555.56$

s = 150.00

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

$V_{s2} = 37233.989$ is calculated for jacket, with:

d = 400.00

$A_v = 100530.965$

$f_y = 555.56$

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: $V_s + V_f \leq 818179.336$

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, $\gamma = 0.85$

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

Consequently:

Jacket

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

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

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

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

Existing Column

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 694.45$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = -3.1831679E-014$

EDGE -B-

Shear Force, $V_b = 3.1831679E-014$

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: $A_{st, \text{ten}} = 911.0619$

-Compression: $A_{st, \text{com}} = 911.0619$

-Middle: $A_{st, \text{mid}} = 556.0619$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.26755321$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 102534.798$

with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 1.5380E+008$

$M_{u1+} = 1.5380E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

Mu1- = 1.5380E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

Mpr2 = Max(Mu2+ , Mu2-) = 1.5380E+008

Mu2+ = 1.5380E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

Mu2- = 1.5380E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

and

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

with

V1 = -3.1831679E-014, is the shear force acting at edge 1 for the the static loading combination

V2 = 3.1831679E-014, is the shear force acting at edge 2 for the the static loading combination

Calculation of Mu1+

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

$\phi_u = 1.7246351E-005$

Mu = 1.5380E+008

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 ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.00514506$

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

From (5.4b), TBDY: $\phi_u = 0.00514506$

we (5.4c) = 0.00169139

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) = 1.25908

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

 $psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25223$

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

 $psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25908$

ps1 (external) = $(Ash1*h1/s1)/Asec = 0.00156298$

Ash1 = Astir_1*ns_1 = 157.0796

No stirups, ns_1 = 2.00

h1 = 400.00

ps2 (internal) = $(Ash2*h2/s2)/Asec = 0.00025008$

Ash2 = Astir_2*ns_2 = 100.531

No stirups, ns_2 = 2.00

h2 = 200.00

$A_{sec} = 268000.00$
 $s_1 = 150.00$
 $s_2 = 300.00$
 $fy_{we1} = 694.45$
 $fy_{we2} = 694.45$
 $f_{ce} = 33.00$
 From ((5.A.5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y_1 = 0.00140044$
 $sh_1 = 0.0044814$
 $ft_1 = 466.8167$
 $fy_1 = 389.0139$
 $su_1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/ld = 0.30$
 $su_1 = 0.4 * esu_1_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_1_{nominal} = 0.08$,
 For calculation of $esu_1_{nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = (fs_{jacket} * A_{sl, ten, jacket} + fs_{core} * A_{sl, ten, core}) / A_{sl, ten} = 389.0139$
 with $Es_1 = (Es_{jacket} * A_{sl, ten, jacket} + Es_{core} * A_{sl, ten, core}) / A_{sl, ten} = 200000.00$
 $y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 466.8167$
 $fy_2 = 389.0139$
 $su_2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/lb, min = 0.30$
 $su_2 = 0.4 * esu_2_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_2_{nominal} = 0.08$,
 For calculation of $esu_2_{nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} * A_{sl, com, jacket} + fs_{core} * A_{sl, com, core}) / A_{sl, com} = 389.0139$
 with $Es_2 = (Es_{jacket} * A_{sl, com, jacket} + Es_{core} * A_{sl, com, core}) / A_{sl, com} = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/ld = 0.30$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and 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 $fsv = (fs_{jacket} * A_{sl, mid, jacket} + fs_{mid} * A_{sl, mid, core}) / A_{sl, mid} = 389.0139$
 with $Es_v = (Es_{jacket} * A_{sl, mid, jacket} + Es_{mid} * A_{sl, mid, core}) / A_{sl, mid} = 200000.00$
 $1 = A_{sl, ten} / (b * d) * (fs_1 / f_c) = 0.04490101$
 $2 = A_{sl, com} / (b * d) * (fs_2 / f_c) = 0.04490101$
 $v = A_{sl, mid} / (b * d) * (fsv / f_c) = 0.0274051$
 and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.05384204$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.05384204$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.03286221$$

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

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

--->
 μ (4.9) = 0.16841906
 M_u = MRc (4.14) = 1.5380E+008
 u = μ (4.1) = 1.7246351E-005

 Calculation of ratio l_b/l_d

 Inadequate Lap Length with $l_b/l_d = 0.30$

 Calculation of μ_{u1} -

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

$$u = 1.7246351E-005$$

$$M_u = 1.5380E+008$$

 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 μ_c : $\mu_c^* = \text{shear_factor} * \text{Max}(\mu_c, c_c) = 0.00514506$
 The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\mu_c = 0.00514506$
 w_e (5.4c) = 0.00169139
 a_{se} ((5.4d), TBDY) = $(a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$

$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.25908$
 Expression ((5.4d), TBDY) for $p_{sh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.25223$
 $ps1$ (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 670.00$
 $ps2$ (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 500.00$

 $p_{sh,y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.25908$
 $ps1$ (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 400.00$

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

$$Ash_2 = Astir_2 * ns_2 = 100.531$$

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$fy_{we1} = 694.45$$

$$fy_{we2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

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

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

$$su_1 = 0.4 * esu_{1_nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esu_{1_nominal} = 0.08$,

For calculation of $esu_{1_nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.

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

$$\text{with } fs_1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 389.0139$$

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

$$y_2 = 0.00140044$$

$$sh_2 = 0.0044814$$

$$ft_2 = 466.8167$$

$$fy_2 = 389.0139$$

$$su_2 = 0.00512$$

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

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

$$su_2 = 0.4 * esu_{2_nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esu_{2_nominal} = 0.08$,

For calculation of $esu_{2_nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered characteristic value $fsy_2 = fs_2 / 1.2$, from table 5.1, TBDY.

y_2, sh_2, ft_2, fy_2 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 389.0139$$

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

$$y_v = 0.00140044$$

$$sh_v = 0.0044814$$

$$ft_v = 466.8167$$

$$fy_v = 389.0139$$

$$suv = 0.00512$$

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

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

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

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

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

For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered characteristic value $fsyv = fsv / 1.2$, from table 5.1, TBDY.

y_v, sh_v, ft_v, fy_v , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 389.0139$$

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

$$1 = A_{sl,ten} / (b * d) * (fs_1 / f_c) = 0.04490101$$

$$2 = A_{sl,com} / (b * d) * (fs_2 / f_c) = 0.04490101$$

$$v = A_{sl,mid} / (b * d) * (fsv / f_c) = 0.0274051$$

and confined core properties:

$$b = 610.00$$

$d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.05384204$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.05384204$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.03286221$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.16841906$
 $Mu = MRc (4.14) = 1.5380E+008$
 $u = su (4.1) = 1.7246351E-005$

 Calculation of ratio l_b/l_d

 Inadequate Lap Length with $l_b/l_d = 0.30$

 Calculation of Mu_{2+}

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.7246351E-005$
 $Mu = 1.5380E+008$

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 : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00514506$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.00514506$
 $we (5.4c) = 0.00169139$
 $ase ((5.4d), TBDY) = (ase1*A_{ext} + ase2*A_{int})/A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$

$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.25908$
 Expression ((5.4d), TBDY) for $psh_{min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25223$
 $ps1 (external) = (A_{sh1} * h1 / s1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 (internal) = (A_{sh2} * h2 / s2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25908
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 = 694.45

fywe2 = 694.45

fce = 33.00

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

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

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

lo/lou,min = lb/d = 0.30

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

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

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

y1, sh1,ft1,fy1, are also multiplied by 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 = 389.0139

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

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

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

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

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

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

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

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

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139

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

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

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

lo/lou,min = lb/d = 0.30

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

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

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

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

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

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

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

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.04490101$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.04490101$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.0274051$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

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

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

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

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.05384204$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.05384204$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.03286221$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$s_u (4.9) = 0.16841906$$

$$\mu_u = M_{Rc} (4.14) = 1.5380E+008$$

$$u = s_u (4.1) = 1.7246351E-005$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_{u2} -

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

$$u = 1.7246351E-005$$

$$\mu_u = 1.5380E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00514506$$

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

$$\text{From (5.4b), TBDY: } c_u = 0.00514506$$

$$w_e (5.4c) = 0.00169139$$

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

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.25908$$

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

$$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25223$$

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

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

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

$$h_1 = 670.00$$

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

$$Ash_2 = Astir_2 * ns_2 = 100.531$$

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

$$h_2 = 500.00$$

$$psh_y * Fy_{we} = psh_1 * Fy_{we1} + ps_2 * Fy_{we2} = 1.25908$$

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

$$Ash_1 = Astir_1 * ns_1 = 157.0796$$

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

$$h_1 = 400.00$$

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

$$Ash_2 = Astir_2 * ns_2 = 100.531$$

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$fy_{we1} = 694.45$$

$$fy_{we2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

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

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

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

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

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.

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

$$\text{with } fs_1 = (fs_{jacket} * A_{sl, ten, jacket} + fs_{core} * A_{sl, ten, core}) / A_{sl, ten} = 389.0139$$

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

$$y_2 = 0.00140044$$

$$sh_2 = 0.0044814$$

$$ft_2 = 466.8167$$

$$fy_2 = 389.0139$$

$$su_2 = 0.00512$$

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

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

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

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

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.

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

$$\text{with } fs_2 = (fs_{jacket} * A_{sl, com, jacket} + fs_{core} * A_{sl, com, core}) / A_{sl, com} = 389.0139$$

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

$$y_v = 0.00140044$$

$$sh_v = 0.0044814$$

$$ft_v = 466.8167$$

$$fy_v = 389.0139$$

$$suv = 0.00512$$

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

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

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

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

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

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

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

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

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.04490101$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.04490101$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.0274051$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

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

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.05384204$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.05384204$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.03286221$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.16841906

$\mu = MR_c$ (4.14) = 1.5380E+008

$u = su$ (4.1) = 1.7246351E-005

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 383231.42$

Calculation of Shear Strength at edge 1, $V_{r1} = 383231.42$

$V_{r1} = V_n$ ((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

$b_w = 670.00$

$d = 320.00$

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

$\mu = 5.3381491E-011$

$V_u = 3.1831679E-014$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 186169.943$

$V_{s1} = 186169.943$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 150.00$

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:

$d_2 = 160.00$

$A_v = 100530.965$

$f_y = 555.56$

$s = 300.00$

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: Vs + Vf <= 818179.336

Calculation of Shear Strength at edge 2, Vr2 = 383231.42
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 = 4.2118567E-011
Vu = 3.1831679E-014

From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 186169.943
Vs1 = 186169.943 is calculated for jacket, with:

d = 320.00
Av = 157079.633
fy = 555.56
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 = 555.56
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: (b)
Section Type: rcjars

Constant Properties

Knowledge Factor, = 0.85

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

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

New material of Primary Member: Steel Strength, fs = fsm = 555.56

Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00

Existing Column

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

New material of Primary Member: Steel Strength, fs = fsm = 555.56

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, $L = 3000.00$
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with $l_b/l_d = 0.30$
No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 1.0660E+007$
Shear Force, $V2 = 5.4482097E-014$
Shear Force, $V3 = 15660.961$
Axial Force, $F = -3615.022$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 709.9999$
-Compression: $A_{sc} = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten} = 709.9999$
-Compression: $A_{sc,com} = 1266.062$
-Middle: $A_{sc,mid} = 402.1239$
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten,jacket} = 402.1239$
-Compression: $A_{sc,com,jacket} = 804.2477$
-Middle: $A_{sc,mid,jacket} = 402.1239$
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten,core} = 307.8761$
-Compression: $A_{sc,com,core} = 461.8141$
-Middle: $A_{sc,mid,core} = 0.00$
Mean Diameter of Tension Reinforcement, $DbL = 15.00$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u,R = 1.0^*$ $u = 0.01042937$
 $u = y + p = 0.01042937$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00042937$ ((4.29), Biskinis Phd))
 $M_y = 1.5367E+008$
 $L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 680.6988
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 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 3.0458651E-006$
with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b/l_d)^{2/3}) = 311.2112$
 $d = 627.00$
 $y = 0.18520765$
 $A = 0.00952871$
 $B = 0.00408012$
with $pt = 0.00283094$
 $pc = 0.00504809$
 $pv = 0.00160336$
 $N = 3615.022$
 $b = 400.00$
 $" = 0.06858054$

y_comp = 1.9040135E-005
with fc = 33.00
Ec = 26999.444
y = 0.18428672
A = 0.00944964
B = 0.0040338
with Es = 200000.00

Calculation of ratio lb/d

Inadequate Lap Length with lb/d = 0.30

- Calculation of p -

From table 10-7: p = 0.01

with:

- Condition iv occurred

Beam controlled by inadequate embedment into beam-column joint:
(lb/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 $V_p/V_o = 0.44897845$

- Transverse Reinforcement: C

- Stirrup Spacing $\leq d/3$

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

= -1.1965793E-006

- 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

$V_s = 386302.632$, already given in calculation of shear control ratio

design Shear = 15660.961

- (-)/ bal = -0.22420649

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

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

' = $A_{sc}/(b_w*d) = 0.00665146$

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

From (B-1), ACI 318-11: bal = 0.01704017

fc = $(f_{c_jacket} * Area_jacket + f_{c_core} * Area_core) / section_area = 33.00$

fy = $f_{y_jacket_bars} = 555.56$

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

From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + y) = 0.51922877$

y = 0.0027778

- $V / (b_w*d*f_c^{0.5}) = 0.13090527$, 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

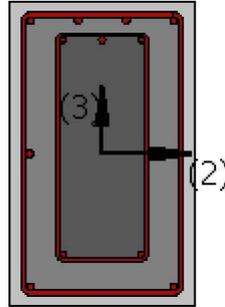
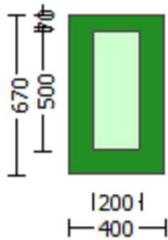
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (3)



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

At local axis: 3

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.85$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$

New material of Primary 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 Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$

New material of Primary 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, $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 6.8007E+006$

Shear Force, $V_a = 4020.305$

EDGE -B-

Bending Moment, $M_b = 1.0660E+007$

Shear Force, $V_b = 15660.961$

BOTH EDGES

Axial Force, $F = -3615.022$

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 $V_R = 1.0 \cdot V_n = 495183.497$

V_n ((22.5.1.1), ACI 318-14) = 495183.497

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: $V_c = 181024.232$

= 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

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / M_u < 1 = 0.78742609$

$M_u = 1.0660E+007$

$V_u = 15660.961$

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: (b)

Calculation No. 8

beam B1, Floor 1

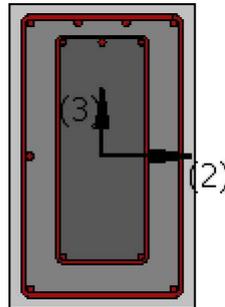
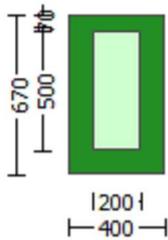
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

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, $\gamma = 0.85$

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

Consequently:

Jacket

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

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

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

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

Existing Column

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 694.45$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

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

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, $V_a = 9840.634$
EDGE -B-
Shear Force, $V_b = 9840.632$
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: $A_{st,ten} = 709.9999$
-Compression: $A_{sc,com} = 1266.062$
-Middle: $A_{st,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.44897845$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 250619.824$
with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 3.6117E+008$
 $\mu_{u1+} = 2.1156E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{u1-} = 3.6117E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 3.6117E+008$
 $\mu_{u2+} = 2.1156E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{u2-} = 3.6117E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = 9840.634$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 9840.632$, is the shear force acting at edge 2 for the static loading combination

Calculation of μ_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 9.5303512E-006$
 $\mu_u = 2.1156E+008$

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

$$f_c = 33.00$$

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

$$\text{Final value of } c_u = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00514506$$

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

$$\text{From (5.4b), TBDY: } c_u = 0.00514506$$

$$w_e \text{ (5.4c)} = 0.00169139$$

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

$$\text{ase1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\text{psh, min} * F_{ywe} = \text{Min}(\text{psh, x} * F_{ywe}, \text{psh, y} * F_{ywe}) = 1.25908$$

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

$$\text{psh, x} * F_{ywe} = \text{psh1} * F_{ywe1} + \text{ps2} * F_{ywe2} = 2.25223$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$\text{psh, y} * F_{ywe} = \text{psh1} * F_{ywe1} + \text{ps2} * F_{ywe2} = 1.25908$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{\text{sec}} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

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

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

$$su_1 = 0.4 * esu_{1, \text{nominal}} \text{ ((5.5), TBDY)} = 0.032$$

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

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.

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

$$\text{with } fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 389.0139$$

$$\text{with } Es_1 = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$$

$$y_2 = 0.00140044$$

$$sh_2 = 0.0044814$$

$$ft_2 = 466.8167$$

$$fy_2 = 389.0139$$

$$su_2 = 0.00512$$

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

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

$$su_2 = 0.4 * esu_2_{nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esu_2_{nominal} = 0.08$,

For calculation of $esu_2_{nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.

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

$$\text{with } fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 389.0139$$

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

$$yv = 0.00140044$$

$$shv = 0.0044814$$

$$ftv = 466.8167$$

$$fyv = 389.0139$$

$$suv = 0.00512$$

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

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

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

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

considering characteristic value $fsyv = fsv/1.2$, 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 $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 389.0139$$

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

$$1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.03337198$$

$$2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.05950845$$

$$v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.01890095$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 33.00$$

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

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

$$1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.04123408$$

$$2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.07352802$$

$$v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.02335381$$

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

---->

$v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied

---->

$$su (4.9) = 0.14317227$$

$$Mu = MRc (4.14) = 2.1156E+008$$

$$u = su (4.1) = 9.5303512E-006$$

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Mu_1 -

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

$$u = 9.8792908E-006$$

$$Mu = 3.6117E+008$$

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: $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00514506$
The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $cu = 0.00514506$

we (5.4c) = 0.00169139

ase ((5.4d), TBDY) = $(ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$

ase1 = 0.14776895

bo_1 = 340.00

ho_1 = 610.00

bi2_1 = 975400.00

ase2 = $\text{Max}(ase1, ase2) = 0.14776895$

bo_2 = 192.00

ho_2 = 492.00

bi2_2 = 557856.00

psh,min*Fywe = $\text{Min}(psh,x * Fywe, psh,y * Fywe) = 1.25908$

Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh_x*Fywe = $psh1 * Fywe1 + ps2 * Fywe2 = 2.25223$

ps1 (external) = $(Ash1 * h1 / s1) / A_{sec} = 0.00261799$

Ash1 = $A_{stir_1} * ns_1 = 157.0796$

No stirrups, 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 stirrups, ns_2 = 2.00

h2 = 500.00

psh_y*Fywe = $psh1 * Fywe1 + ps2 * Fywe2 = 1.25908$

ps1 (external) = $(Ash1 * h1 / s1) / A_{sec} = 0.00156298$

Ash1 = $A_{stir_1} * ns_1 = 157.0796$

No stirrups, 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 stirrups, ns_2 = 2.00

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 0.30

su1 = $0.4 * esu1_nominal$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1, ft1, fy1, it is considered
characteristic value fsy1 = $fs1 / 1.2$, from table 5.1, TBDY.

y1, sh1, ft1, fy1, are also multiplied by $\text{Min}(1, 1.25 * (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = $(fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 389.0139$

with $E_{s1} = (E_{s,jacket} \cdot A_{s,ten,jacket} + E_{s,core} \cdot A_{s,ten,core}) / A_{s,ten} = 200000.00$
 $y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 466.8167$
 $fy_2 = 389.0139$
 $su_2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_0/l_{ou,min} = l_b/l_{b,min} = 0.30$
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fs_2 = fs_2/1.2$, 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 $fs_2 = (fs_{jacket} \cdot A_{s,com,jacket} + fs_{core} \cdot A_{s,com,core}) / A_{s,com} = 389.0139$
 with $E_{s2} = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_0/l_{ou,min} = l_b/l_d = 0.30$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fs_v = fs_v/1.2$, 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 $fs_v = (fs_{jacket} \cdot A_{s,mid,jacket} + fs_{mid} \cdot A_{s,mid,core}) / A_{s,mid} = 389.0139$
 with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.05950845$
 $2 = A_{s,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.03337198$
 $v = A_{s,mid} / (b \cdot d) \cdot (fs_v / fc) = 0.01890095$
 and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.07352802$
 $2 = A_{s,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.04123408$
 $v = A_{s,mid} / (b \cdot d) \cdot (fs_v / fc) = 0.02335381$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_s, y_2$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.17343568$
 $Mu = MRc (4.14) = 3.6117E+008$
 $u = su (4.1) = 9.8792908E-006$

 Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

 Calculation of Mu_{2+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 9.5303512E-006$$

$$\mu = 2.1156E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.00514506$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.00514506$$

$$w_e \text{ (5.4c)} = 0.00169139$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25223$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25908$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A.5), TBDY), TBDY: } \phi_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o / l_{ou, \min} = l_b / d = 0.30$$

$$su_1 = 0.4 * e_{su1_nominal} \text{ ((5.5), TBDY)} = 0.032$$

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 $fs1 = (fs_{jacket} \cdot Asl_{ten,jacket} + fs_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 389.0139$

with $Es1 = (Es_{jacket} \cdot Asl_{ten,jacket} + Es_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 200000.00$

$y2 = 0.00140044$

$sh2 = 0.0044814$

$ft2 = 466.8167$

$fy2 = 389.0139$

$su2 = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$

and also multiplied by the $shear_factor$ according to 15.7.1.4, with

$Shear_factor = 1.00$

$lo/lou, min = lb/lb, min = 0.30$

$su2 = 0.4 \cdot esu2_nominal$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 389.0139$

with $Es2 = (Es_{jacket} \cdot Asl_{com,jacket} + Es_{core} \cdot Asl_{com,core}) / Asl_{com} = 200000.00$

$yv = 0.00140044$

$shv = 0.0044814$

$ftv = 466.8167$

$fyv = 389.0139$

$suv = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$

and also multiplied by the $shear_factor$ according to 15.7.1.4, with

$Shear_factor = 1.00$

$lo/lou, min = lb/ld = 0.30$

$suv = 0.4 \cdot esuv_nominal$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esuv_nominal = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 389.0139$

with $Es_v = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$

$1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.03337198$

$2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.05950845$

$v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.01890095$

and confined core properties:

$b = 340.00$

$d = 597.00$

$d' = 13.00$

fcc (5A.2, TBDY) = 33.00

cc (5A.5, TBDY) = 0.002

$c = \text{confinement factor} = 1.00$

$1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.04123408$

$2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.07352802$

$v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.02335381$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < vs, y2$ - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.14317227

$Mu = MRc$ (4.14) = 2.1156E+008

$u = su$ (4.1) = 9.5303512E-006

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Mu2-

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\mu = 9.8792908E-006$$

$$\text{Mu} = 3.6117E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu, c_o) = 0.00514506$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu = 0.00514506$$

$$\mu_e \text{ (5.4c)} = 0.00169139$$

$$\mu_{ase} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\mu_{psh, \min} * F_{ywe} = \text{Min}(\mu_{psh, x} * F_{ywe}, \mu_{psh, y} * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for $\mu_{psh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\mu_{psh, x} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{psh2} * F_{ywe2} = 2.25223$$

$$\mu_{psh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\mu_{psh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\mu_{psh, y} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{psh2} * F_{ywe2} = 1.25908$$

$$\mu_{psh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\mu_{psh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A.5), TBDY), TBDY: } c_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_o/l_{ou,min} = l_b/l_d = 0.30$$

$$s_u1 = 0.4 * e_{su1,nominal} ((5.5), TBDY) = 0.032$$

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 $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } f_{s1} = (f_{s,jacket} * A_{s,ten,jacket} + f_{s,core} * A_{s,ten,core}) / A_{s,ten} = 389.0139$$

$$\text{with } E_{s1} = (E_{s,jacket} * A_{s,ten,jacket} + E_{s,core} * A_{s,ten,core}) / A_{s,ten} = 200000.00$$

$$y_2 = 0.00140044$$

$$sh_2 = 0.0044814$$

$$ft_2 = 466.8167$$

$$fy_2 = 389.0139$$

$$s_u2 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$$

$$s_u2 = 0.4 * e_{su2,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{su2,nominal} = 0.08$,

For calculation of $e_{su2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $f_{sy2} = f_{s2}/1.2$, from table 5.1, TBDY.

y_2, sh_2, ft_2, fy_2 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } f_{s2} = (f_{s,jacket} * A_{s,com,jacket} + f_{s,core} * A_{s,com,core}) / A_{s,com} = 389.0139$$

$$\text{with } E_{s2} = (E_{s,jacket} * A_{s,com,jacket} + E_{s,core} * A_{s,com,core}) / A_{s,com} = 200000.00$$

$$y_v = 0.00140044$$

$$sh_v = 0.0044814$$

$$ft_v = 466.8167$$

$$fy_v = 389.0139$$

$$s_uv = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_o/l_{ou,min} = l_b/l_d = 0.30$$

$$s_{uv} = 0.4 * e_{suv,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{suv,nominal} = 0.08$,

considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY

For calculation of $e_{suv,nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 389.0139$$

$$\text{with } E_{sv} = (E_{s,jacket} * A_{s,mid,jacket} + E_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 200000.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.05950845$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.03337198$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.01890095$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 33.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.07352802$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.04123408$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.02335381$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.17343568$$

$$\mu_u = M_{Rc} (4.14) = 3.6117E+008$$

$$u = s_u (4.1) = 9.8792908E-006$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 558200.119$

Calculation of Shear Strength at edge 1, $V_{r1} = 558200.119$
 $V_{r1} = V_n$ ((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: $V_c = 209131.476$
= 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
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu_u < 1 = 1.00$
 $\mu_u = 1.0197E+006$
 $V_u = 9840.634$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 349068.643$
 $V_{s1} = 311834.654$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 37233.989$ is calculated for jacket, with:
 $d_2 = 400.00$
 $A_v = 100530.965$
 $f_y = 555.56$
 $s = 300.00$
 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, $V_{r2} = 558200.119$
 $V_{r2} = V_n$ ((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: $V_c = 209131.476$
= 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
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu_u < 1 = 1.00$
 $\mu_u = 1.0197E+006$
 $V_u = 9840.632$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 349068.643$
 $V_{s1} = 311834.654$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs2 = 37233.989 is calculated for jacket, with:
d = 400.00
Av = 100530.965
fy = 555.56
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, = 0.85
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
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 = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lo,min = 0.30
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = -3.1831679E-014
EDGE -B-
Shear Force, Vb = 3.1831679E-014

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: $As_{t,ten} = 911.0619$

-Compression: $As_{c,com} = 911.0619$

-Middle: $As_{mid} = 556.0619$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.26755321$

Member Controlled by Flexure ($V_e/V_r < 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 102534.798$
with

$M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 1.5380E+008$

$Mu_{1+} = 1.5380E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$Mu_{1-} = 1.5380E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

$M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 1.5380E+008$

$Mu_{2+} = 1.5380E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

$Mu_{2-} = 1.5380E+008$, 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

$V_1 = -3.1831679E-014$, is the shear force acting at edge 1 for the the static loading combination

$V_2 = 3.1831679E-014$, 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:

$\phi_u = 1.7246351E-005$

$M_u = 1.5380E+008$

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 : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00514506$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\phi_u = 0.00514506$

w_e (5.4c) = 0.00169139

ase ((5.4d), TBDY) = $(ase_1 \cdot A_{ext} + ase_2 \cdot A_{int})/A_{sec} = 0.14776895$

$ase_1 = 0.14776895$

$bo_1 = 340.00$

$ho_1 = 610.00$

$bi_2_1 = 975400.00$

$ase_2 = \text{Max}(ase_1, ase_2) = 0.14776895$

$bo_2 = 192.00$

$ho_2 = 492.00$

$bi_2_2 = 557856.00$

$psh_{min} \cdot F_{ywe} = \text{Min}(psh_x \cdot F_{ywe}, psh_y \cdot F_{ywe}) = 1.25908$

Expression ((5.4d), TBDY) for $psh_{min} \cdot F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25223
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 = 1.25908
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 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.30

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 * (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.30

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 * (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.30

sv = 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 = 389.0139

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.04490101

2 = Asl,com/(b*d)*(fs2/fc) = 0.04490101

v = Asl,mid/(b*d)*(fsv/fc) = 0.0274051

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 33.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.05384204

2 = Asl,com/(b*d)*(fs2/fc) = 0.05384204

v = Asl,mid/(b*d)*(fsv/fc) = 0.03286221

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

v < vs,y2 - LHS eq.(4.5) is satisfied

---->

su (4.9) = 0.16841906

Mu = MRc (4.14) = 1.5380E+008

u = su (4.1) = 1.7246351E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 1.7246351E-005

Mu = 1.5380E+008

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) = 0.00514506

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.00514506

we (5.4c) = 0.00169139

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

$$bi2_2 = 557856.00$$

$$psh_min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.25908$$

Expression ((5.4d), TBDY) for $psh_min*Fywe$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.25223$$

$$ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00261799$$

$$Ash1 = Astir_1*ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00062519$$

$$Ash2 = Astir_2*ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.25908$$

$$ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00156298$$

$$Ash1 = Astir_1*ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00025008$$

$$Ash2 = Astir_2*ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 694.45$$

$$fce = 33.00$$

From ((5.A5), TBDY), TBDY: $cc = 0.002$

$c = \text{confinement factor} = 1.00$

$$y1 = 0.00140044$$

$$sh1 = 0.0044814$$

$$ft1 = 466.8167$$

$$fy1 = 389.0139$$

$$su1 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with $\text{Shear_factor} = 1.00$

$$lo/lou,min = lb/l_d = 0.30$$

$$su1 = 0.4*esu1_nominal \text{ ((5.5), TBDY)} = 0.032$$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25*(lb/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139$$

$$\text{with } Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$$

$$y2 = 0.00140044$$

$$sh2 = 0.0044814$$

$$ft2 = 466.8167$$

$$fy2 = 389.0139$$

$$su2 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with $\text{Shear_factor} = 1.00$

$$lo/lou,min = lb/l_b,min = 0.30$$

$$su2 = 0.4*esu2_nominal \text{ ((5.5), TBDY)} = 0.032$$

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25*(lb/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139$$

$$\text{with } Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$$

$$yv = 0.00140044$$

$$shv = 0.0044814$$

$$ftv = 466.8167$$

$$fyv = 389.0139$$

$$suv = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lo_{u,min} = lb/ld = 0.30$$

$$suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_{nominal}$ and yv , shv , ftv , fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

$y1$, $sh1$, $ft1$, $fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 389.0139$$

$$\text{with } Esv = (Es_{jacket} * Asl_{mid,jacket} + Es_{mid} * Asl_{mid,core}) / Asl_{mid} = 200000.00$$

$$1 = Asl_{ten} / (b * d) * (fs1 / fc) = 0.04490101$$

$$2 = Asl_{com} / (b * d) * (fs2 / fc) = 0.04490101$$

$$v = Asl_{mid} / (b * d) * (fsv / fc) = 0.0274051$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 33.00$$

$$cc (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = Asl_{ten} / (b * d) * (fs1 / fc) = 0.05384204$$

$$2 = Asl_{com} / (b * d) * (fs2 / fc) = 0.05384204$$

$$v = Asl_{mid} / (b * d) * (fsv / fc) = 0.03286221$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < vs, y2$ - LHS eq.(4.5) is satisfied

--->

$$su (4.9) = 0.16841906$$

$$Mu = MRc (4.14) = 1.5380E+008$$

$$u = su (4.1) = 1.7246351E-005$$

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Mu_{2+}

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 1.7246351E-005$$

$$Mu = 1.5380E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$fc = 33.00$$

$$co (5A.5, TBDY) = 0.002$$

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00514506$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } cu = 0.00514506$$

$$we (5.4c) = 0.00169139$$

$$ase ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.25908

Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25223
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25908
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00

y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 0.30

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by 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 = 389.0139

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.30

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

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 $fs_2 = (fs_{jacket} \cdot A_{s1,com,jacket} + fs_{core} \cdot A_{s1,com,core}) / A_{s1,com} = 389.0139$

with $Es_2 = (Es_{jacket} \cdot A_{s1,com,jacket} + Es_{core} \cdot A_{s1,com,core}) / A_{s1,com} = 200000.00$

$y_v = 0.00140044$

$sh_v = 0.0044814$

$ft_v = 466.8167$

$fy_v = 389.0139$

$suv = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$l_o/l_{o,min} = l_b/l_d = 0.30$

$suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered

characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fsv = (fs_{jacket} \cdot A_{s,mid,jacket} + fs_{mid} \cdot A_{s,mid,core}) / A_{s,mid} = 389.0139$

with $Es_v = (Es_{jacket} \cdot A_{s,mid,jacket} + Es_{mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$

$1 = A_{s,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.04490101$

$2 = A_{s,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.04490101$

$v = A_{s,mid} / (b \cdot d) \cdot (fsv / fc) = 0.0274051$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

fcc (5A.2, TBDY) = 33.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

$1 = A_{s,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.05384204$

$2 = A_{s,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.05384204$

$v = A_{s,mid} / (b \cdot d) \cdot (fsv / fc) = 0.03286221$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.16841906

$Mu = MRc$ (4.14) = 1.5380E+008

$u = su$ (4.1) = 1.7246351E-005

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Mu_2 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 1.7246351E-005$

$Mu = 1.5380E+008$

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 : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.00514506$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $cu = 0.00514506$
 we (5.4c) = 0.00169139
 ase ((5.4d), TBDY) = $(ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$

$psh_{min} \cdot F_{ywe} = \text{Min}(psh_x \cdot F_{ywe}, psh_y \cdot F_{ywe}) = 1.25908$

Expression ((5.4d), TBDY) for $psh_{min} \cdot F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $psh_x \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 2.25223$
 $ps1$ (external) = $(Ash1 \cdot h1 / s1) / A_{sec} = 0.00261799$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2$ (internal) = $(Ash2 \cdot h2 / s2) / A_{sec} = 0.00062519$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

 $psh_y \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 1.25908$
 $ps1$ (external) = $(Ash1 \cdot h1 / s1) / A_{sec} = 0.00156298$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2$ (internal) = $(Ash2 \cdot h2 / s2) / A_{sec} = 0.00025008$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

 $A_{sec} = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 694.45$
 $fywe2 = 694.45$
 $f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$

$y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 466.8167$
 $fy1 = 389.0139$
 $su1 = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$lo/lou_{min} = lb/ld = 0.30$

$su1 = 0.4 \cdot esu1_{nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu1_{nominal} = 0.08$,

For calculation of $esu1_{nominal}$ and $y1, sh1, ft1, fy1$, it is considered characteristic value $fsy1 = fs1 / 1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs_{jacket} \cdot A_{sl,ten,jacket} + fs_{core} \cdot A_{sl,ten,core}) / A_{sl,ten} = 389.0139$

with $Es1 = (Es_{jacket} \cdot A_{sl,ten,jacket} + Es_{core} \cdot A_{sl,ten,core}) / A_{sl,ten} = 200000.00$

$y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 466.8167$
 $fy2 = 389.0139$
 $su2 = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o/l_{o,min} = l_b/l_{b,min} = 0.30$$

$$s_u2 = 0.4 * e_{s_u2,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{s_u2,nominal} = 0.08$,

For calculation of $e_{s_u2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered characteristic value $f_{s_y2} = f_{s_2}/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } f_{s_2} = (f_{s,jacket} * A_{s_l,com,jacket} + f_{s,core} * A_{s_l,com,core}) / A_{s_l,com} = 389.0139$$

$$\text{with } E_{s_2} = (E_{s,jacket} * A_{s_l,com,jacket} + E_{s,core} * A_{s_l,com,core}) / A_{s_l,com} = 200000.00$$

$$y_v = 0.00140044$$

$$sh_v = 0.0044814$$

$$ft_v = 466.8167$$

$$fy_v = 389.0139$$

$$s_{u_v} = 0.00512$$

using (30) in Bisikinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o/l_{o,min} = l_b/l_d = 0.30$$

$$s_{u_v} = 0.4 * e_{s_{u_v},nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{s_{u_v},nominal} = 0.08$,

considering characteristic value $f_{s_{u_v}} = f_{s_v}/1.2$, from table 5.1, TBDY

For calculation of $e_{s_{u_v},nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered characteristic value $f_{s_{u_v}} = f_{s_v}/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } f_{s_v} = (f_{s,jacket} * A_{s_l,mid,jacket} + f_{s,mid} * A_{s_l,mid,core}) / A_{s_l,mid} = 389.0139$$

$$\text{with } E_{s_v} = (E_{s,jacket} * A_{s_l,mid,jacket} + E_{s,mid} * A_{s_l,mid,core}) / A_{s_l,mid} = 200000.00$$

$$1 = A_{s_l,ten} / (b * d) * (f_{s_1} / f_c) = 0.04490101$$

$$2 = A_{s_l,com} / (b * d) * (f_{s_2} / f_c) = 0.04490101$$

$$v = A_{s_l,mid} / (b * d) * (f_{s_v} / f_c) = 0.0274051$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 33.00$$

$$cc (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{s_l,ten} / (b * d) * (f_{s_1} / f_c) = 0.05384204$$

$$2 = A_{s_l,com} / (b * d) * (f_{s_2} / f_c) = 0.05384204$$

$$v = A_{s_l,mid} / (b * d) * (f_{s_v} / f_c) = 0.03286221$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

$v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied

---->

$$s_u (4.9) = 0.16841906$$

$$\mu_u = M_{Rc} (4.14) = 1.5380E+008$$

$$u = s_u (4.1) = 1.7246351E-005$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 383231.42$

Calculation of Shear Strength at edge 1, $V_{r1} = 383231.42$

$$V_{r1} = V_n ((22.5.1.1), ACI 318-14)$$

NOTE: In expression (22.5.1.1) 'V_w' is replaced by 'V_w + f * V_f'
where V_f is the contribution of FRPs (11.3), ACI 440).

$$\text{From Table (22.5.5.1), ACI 318-14: } V_c = 197061.477$$

$$= 1 \text{ (normal-weight concrete)}$$

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)

$pw = A_s/(bw*d) = 0.00331157$
As (tension reinf.) = 709.9999
bw = 670.00
d = 320.00
 $V_u*d/M_u < 1 = 0.00$
Mu = 5.3381491E-011
Vu = 3.1831679E-014

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 186169.943$

$V_{s1} = 186169.943$ is calculated for jacket, with:

d = 320.00
Av = 157079.633
fy = 555.56
s = 150.00

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 0.00$ is calculated for jacket, with:

d2 = 160.00
Av = 100530.965
fy = 555.56
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: $V_s + V_f \leq 818179.336$

Calculation of Shear Strength at edge 2, $V_{r2} = 383231.42$

$V_{r2} = V_n$ ((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: $fc' = (fc'_{jacket}*Area_{jacket} + fc'_{core}*Area_{core})/Area_{section} = 33.00$, but $fc'^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)

$pw = A_s/(bw*d) = 0.00331157$
As (tension reinf.) = 709.9999
bw = 670.00
d = 320.00

$V_u*d/M_u < 1 = 0.00$
Mu = 4.2118567E-011
Vu = 3.1831679E-014

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 186169.943$

$V_{s1} = 186169.943$ is calculated for jacket, with:

d = 320.00
Av = 157079.633
fy = 555.56
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
Av = 100530.965
fy = 555.56
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, $\phi = 0.85$

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$

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, $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_b/l_d = 0.30$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = -4.6355638E-011$

Shear Force, $V_2 = 5.4482097E-014$

Shear Force, $V_3 = 15660.961$

Axial Force, $F = -3615.022$

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: $A_{sl,mid} = 556.0619$

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten,jacket} = 603.1858$

-Compression: $A_{sl,com,jacket} = 603.1858$

-Middle: $A_{sl,mid,jacket} = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten,core} = 307.8761$

-Compression: $A_{sl,com,core} = 307.8761$

-Middle: $A_{sl,mid,core} = 153.938$

Mean Diameter of Tension Reinforcement, $DbL = 15.20$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_{,R} = 1.0^*$ $u = 0.00693154$

$u = y + p = 0.00693154$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00193154$ ((4.29), Biskinis Phd))

$M_y = 1.1181E+008$

$L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 1500.00

From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 2.8943E+013$

Calculation of Yielding Moment M_y

Calculation of γ and M_y according to Annex 7 -

$y = \text{Min}(y_{\text{ten}}, y_{\text{com}})$
 $y_{\text{ten}} = 5.6157722\text{E-}006$
with $((10.1), \text{ASCE 41-17}) f_y = \text{Min}(f_y, 1.25 \cdot f_y \cdot (l_b/d)^{2/3}) = 311.2112$
 $d = 357.00$
 $y = 0.2238468$
 $A = 0.00999123$
 $B = 0.00561868$
with $pt = 0.00380895$
 $pc = 0.00380895$
 $pv = 0.00232477$
 $N = 3615.022$
 $b = 670.00$
 $" = 0.12044818$
 $y_{\text{comp}} = 2.7622786\text{E-}005$
with $fc = 33.00$
 $E_c = 26999.444$
 $y = 0.22309812$
 $A = 0.00990831$
 $B = 0.00557012$
with $E_s = 200000.00$

Calculation of ratio l_b/d

Inadequate Lap Length with $l_b/d = 0.30$

- Calculation of p -

From table 10-7: $p = 0.005$

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 $V_p/V_o = 0.26755321$
- Transverse Reinforcement: NC
- Stirrup Spacing $> d/3$
- Low ductility demand, $\gamma / y < 2$ (table 10-6, ASCE 41-17)
 $= -4.9616748\text{E-}022$
- Stirrup Spacing $\leq d/2$
 $d = d_{\text{external}} = 357.00$
 $s = s_{\text{external}} = 150.00$
- Strength provided by hoops $V_s < 3/4 \cdot \text{design Shear}$
 $V_s = 215957.134$, already given in calculation of shear control ratio
design Shear = $5.4482097\text{E-}014$
- (ρ_s) / $\rho_{\text{bal}} = -0.23508921$
 $= A_{st}/(b_w \cdot d) = 0.00296835$
Tension Reinf Area: $A_{st} = 709.9999$
 $\rho_s = A_{sc}/(b_w \cdot d) = 0.00697431$
Compression Reinf Area: $A_{sc} = 1668.186$
- From (B-1), ACI 318-11: $\rho_{\text{bal}} = 0.01704017$
 $fc = (fc_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + fc_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{section_area} = 33.00$
 $f_y = f_{y_{\text{jacket_bars}}} = 555.56$
From 10.2.7.3, ACI 318-11: $\rho_1 = 0.65$
From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + \gamma) = 0.51922877$
 $\gamma = 0.0027778$
- $V / (b_w \cdot d \cdot fc^{0.5}) = 4.7750405\text{E-}019$, NOTE: units in lb & in

$bw = 670.00$

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)

Calculation No. 9

beam B1, Floor 1

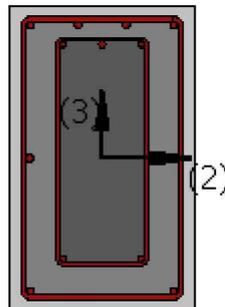
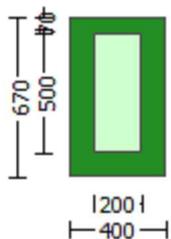
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.85$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$

New material of Primary 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 Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$

New material of Primary 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, $L = 3000.00$
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with $l_o/l_{o,min} = l_b/l_d = 0.30$
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, $M_a = -1.5217172E-010$
Shear Force, $V_a = -6.6781494E-014$
EDGE -B-
Bending Moment, $M_b = -4.8656409E-011$
Shear Force, $V_b = 6.6781494E-014$
BOTH EDGES
Axial Force, $F = -4363.163$
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, $Db_{L,ten} = 15.20$

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) '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: $V_c = 171520.00$
= 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
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 1.5217172E-010$
 $V_u = 6.6781494E-014$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 167551.608$
 $V_{s1} = 167551.608$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 500.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 0.00$ is calculated for core, with:
 $d = 160.00$
 $A_v = 100530.965$
 $f_y = 500.00$
 $s = 300.00$

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. 10

beam B1, Floor 1

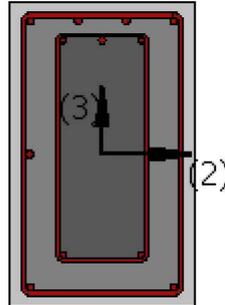
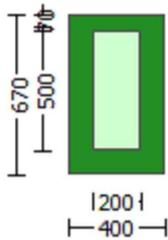
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

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, $\gamma = 0.85$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$

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, $f_s = 1.25 \cdot f_{sm} = 694.45$

Existing Column

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 694.45$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{ou,min} = 0.30$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 9840.634$

EDGE -B-

Shear Force, $V_b = 9840.632$

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: $A_{st,ten} = 709.9999$

-Compression: $A_{st,com} = 1266.062$

-Middle: $A_{st,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.44897845$

Member Controlled by Flexure ($V_e/V_r < 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 250619.824$

with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 3.6117E+008$

$M_{u1+} = 2.1156E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$M_{u1-} = 3.6117E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 3.6117E+008$

$M_{u2+} = 2.1156E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

$M_{u2-} = 3.6117E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

and

$\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$

with

$V_1 = 9840.634$, is the shear force acting at edge 1 for the the static loading combination

$V_2 = 9840.632$, is the shear force acting at edge 2 for the the static loading combination

Calculation of M_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 9.5303512E-006$$

$$\mu = 2.1156E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o(5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.00514506$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.00514506$$

$$\phi_{we} \text{ (5.4c)} = 0.00169139$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\phi_{psh, \min} * F_{ywe} = \text{Min}(\phi_{psh, x} * F_{ywe}, \phi_{psh, y} * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for $\phi_{psh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{psh, x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 2.25223$$

$$\phi_{psh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{psh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{psh, y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 1.25908$$

$$\phi_{psh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{psh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_0/l_{ou,min} = l_b/l_d = 0.30$$

$$s_u1 = 0.4 * e_{su1,nominal} ((5.5), TBDY) = 0.032$$

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 $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } f_{s1} = (f_{s,jacket} * A_{s1,ten,jacket} + f_{s,core} * A_{s1,ten,core}) / A_{s1,ten} = 389.0139$$

$$\text{with } E_{s1} = (E_{s,jacket} * A_{s1,ten,jacket} + E_{s,core} * A_{s1,ten,core}) / A_{s1,ten} = 200000.00$$

$$y_2 = 0.00140044$$

$$sh_2 = 0.0044814$$

$$ft_2 = 466.8167$$

$$fy_2 = 389.0139$$

$$s_u2 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_0/l_{ou,min} = l_b/l_{b,min} = 0.30$$

$$s_u2 = 0.4 * e_{su2,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{su2,nominal} = 0.08$,

For calculation of $e_{su2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered characteristic value $f_{sy2} = f_{s2}/1.2$, from table 5.1, TBDY.

y_2, sh_2, ft_2, fy_2 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } f_{s2} = (f_{s,jacket} * A_{s2,com,jacket} + f_{s,core} * A_{s2,com,core}) / A_{s2,com} = 389.0139$$

$$\text{with } E_{s2} = (E_{s,jacket} * A_{s2,com,jacket} + E_{s,core} * A_{s2,com,core}) / A_{s2,com} = 200000.00$$

$$y_v = 0.00140044$$

$$sh_v = 0.0044814$$

$$ft_v = 466.8167$$

$$fy_v = 389.0139$$

$$s_{uv} = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_0/l_{ou,min} = l_b/l_d = 0.30$$

$$s_{uv} = 0.4 * e_{suv,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{suv,nominal} = 0.08$,

considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY

For calculation of $e_{suv,nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 389.0139$$

$$\text{with } E_{sv} = (E_{s,jacket} * A_{s,mid,jacket} + E_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 200000.00$$

$$1 = A_{s1,ten} / (b * d) * (f_{s1} / f_c) = 0.03337198$$

$$2 = A_{s2,com} / (b * d) * (f_{s2} / f_c) = 0.05950845$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.01890095$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 33.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{s1,ten} / (b * d) * (f_{s1} / f_c) = 0.04123408$$

$$2 = A_{s2,com} / (b * d) * (f_{s2} / f_c) = 0.07352802$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.02335381$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.14317227$$

$$\mu = M_{Rc} (4.14) = 2.1156E+008$$

$$u = s_u (4.1) = 9.5303512E-006$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Mu1-

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\mu = 9.8792908E-006$$

$$Mu = 3.6117E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00514506$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00514506$$

$$w_e \text{ (5.4c)} = 0.00169139$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25223$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

No stirrups, $n_{s_1} = 2.00$

$$h_1 = 670.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

No stirrups, $n_{s_2} = 2.00$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25908$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

No stirrups, $n_{s_1} = 2.00$

$$h_1 = 400.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

No stirrups, $n_{s_2} = 2.00$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

From ((5.A5), TBDY), TBDY: $c_c = 0.002$

c = confinement factor = 1.00

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$f_{y1} = 389.0139$
 $s_{u1} = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $s_{u1} = 0.4 * e_{s1_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $e_{s1_nominal} = 0.08$,
 For calculation of $e_{s1_nominal}$ and y_1, sh_1, ft_1, f_{y1} , it is considered
 characteristic value $f_{s1} = f_{s1}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, f_{y1} , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{s1} = (f_{s,jacket} * A_{s1,ten,jacket} + f_{s,core} * A_{s1,ten,core}) / A_{s1,ten} = 389.0139$
 with $E_{s1} = (E_{s,jacket} * A_{s1,ten,jacket} + E_{s,core} * A_{s1,ten,core}) / A_{s1,ten} = 200000.00$
 $y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 466.8167$
 $f_{y2} = 389.0139$
 $s_{u2} = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$
 $s_{u2} = 0.4 * e_{s2_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $e_{s2_nominal} = 0.08$,
 For calculation of $e_{s2_nominal}$ and y_2, sh_2, ft_2, f_{y2} , it is considered
 characteristic value $f_{s2} = f_{s2}/1.2$, from table 5.1, TBDY.
 y_2, sh_2, ft_2, f_{y2} , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{s2} = (f_{s,jacket} * A_{s2,com,jacket} + f_{s,core} * A_{s2,com,core}) / A_{s2,com} = 389.0139$
 with $E_{s2} = (E_{s,jacket} * A_{s2,com,jacket} + E_{s,core} * A_{s2,com,core}) / A_{s2,com} = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $f_{y_v} = 389.0139$
 $s_{u_v} = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $s_{u_v} = 0.4 * e_{s_{u_v}}_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $e_{s_{u_v}}_nominal = 0.08$,
 considering characteristic value $f_{s_{u_v}} = f_{s_{u_v}}/1.2$, from table 5.1, TBDY
 For calculation of $e_{s_{u_v}}_nominal$ and y_v, sh_v, ft_v, f_{y_v} , it is considered
 characteristic value $f_{s_{u_v}} = f_{s_{u_v}}/1.2$, from table 5.1, TBDY.
 y_v, sh_v, ft_v, f_{y_v} , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{s_{u_v}} = (f_{s,jacket} * A_{s_{u_v},mid,jacket} + f_{s,mid} * A_{s_{u_v},mid,core}) / A_{s_{u_v},mid} = 389.0139$
 with $E_{s_{u_v}} = (E_{s,jacket} * A_{s_{u_v},mid,jacket} + E_{s,mid} * A_{s_{u_v},mid,core}) / A_{s_{u_v},mid} = 200000.00$
 $1 = A_{s1,ten} / (b * d) * (f_{s1} / f_c) = 0.05950845$
 $2 = A_{s2,com} / (b * d) * (f_{s2} / f_c) = 0.03337198$
 $v = A_{s_{u_v},mid} / (b * d) * (f_{s_{u_v}} / f_c) = 0.01890095$
 and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{s1,ten} / (b * d) * (f_{s1} / f_c) = 0.07352802$
 $2 = A_{s2,com} / (b * d) * (f_{s2} / f_c) = 0.04123408$
 $v = A_{s_{u_v},mid} / (b * d) * (f_{s_{u_v}} / f_c) = 0.02335381$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $s_u (4.9) = 0.17343568$
 $M_u = M_{Rc} (4.14) = 3.6117E+008$
 $u = s_u (4.1) = 9.8792908E-006$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_{2+}

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\mu = 9.5303512E-006$$

$$\mu = 2.1156E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu_c, \mu_{cc}) = 0.00514506$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu_c = 0.00514506$$

$$\mu_{cc} \text{ (5.4c)} = 0.00169139$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for $p_{sh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25223$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh,y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25908$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

From ((5.A.5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 466.8167$
 $fy1 = 389.0139$
 $su1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/d = 0.30$
 $su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu1_nominal = 0.08$,
 For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25*(lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139$
 with $Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$
 $y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 466.8167$
 $fy2 = 389.0139$
 $su2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/lb,min = 0.30$
 $su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ 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 $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139$
 with $Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$
 $yv = 0.00140044$
 $shv = 0.0044814$
 $ftv = 466.8167$
 $fyv = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/d = 0.30$
 $suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25*(lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139$
 with $Es_v = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.03337198$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.05950845$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.01890095$
 and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.04123408$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.07352802$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.02335381$

Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u(4.9) = 0.14317227$$

$$M_u = M_{Rc}(4.14) = 2.1156E+008$$

$$u = s_u(4.1) = 9.5303512E-006$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of M_{u2} -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 9.8792908E-006$$

$$M_u = 3.6117E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o(5A.5, TBDY) = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00514506$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00514506$$

$$w_e(5.4c) = 0.00169139$$

$$a_{se}((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i21} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i22} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25223$$

$$p_{s1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir, 1} * n_{s, 1} = 157.0796$$

$$\text{No stirrups, } n_{s, 1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir, 2} * n_{s, 2} = 100.531$$

$$\text{No stirrups, } n_{s, 2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25908$$

$$p_{s1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir, 1} * n_{s, 1} = 157.0796$$

$$\text{No stirrups, } n_{s, 1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir, 2} * n_{s, 2} = 100.531$$

$$\text{No stirrups, } n_{s, 2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

s1 = 150.00
s2 = 300.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00

y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.30

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.30

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.30

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.05950845

2 = Asl,com/(b*d)*(fs2/fc) = 0.03337198

v = Asl,mid/(b*d)*(fsv/fc) = 0.01890095

and confined core properties:

b = 340.00
d = 597.00
d' = 13.00

fcc (5A.2, TBDY) = 33.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.07352802

$$2 = A_{s1,com}/(b*d)*(f_s2/f_c) = 0.04123408$$

$$v = A_{s1,mid}/(b*d)*(f_{sv}/f_c) = 0.02335381$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

---->

$$s_u(4.9) = 0.17343568$$

$$\mu_u = M_{Rc}(4.14) = 3.6117E+008$$

$$u = s_u(4.1) = 9.8792908E-006$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 558200.119$

Calculation of Shear Strength at edge 1, $V_{r1} = 558200.119$

$V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f*V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 209131.476$

= 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)

$$p_w = A_s/(b_w*d) = 0.00331157$$

$$A_s \text{ (tension reinf.)} = 709.9999$$

$$b_w = 400.00$$

$$d = 536.00$$

$$V_u*d/\mu_u < 1 = 1.00$$

$$\mu_u = 1.0197E+006$$

$$V_u = 9840.634$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 349068.643$

$V_{s1} = 311834.654$ is calculated for jacket, with:

$$d = 536.00$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 37233.989$ is calculated for jacket, with:

$$d_2 = 400.00$$

$$A_v = 100530.965$$

$$f_y = 555.56$$

$$s = 300.00$$

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, $V_{r2} = 558200.119$

$V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f*V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 209131.476$

= 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)

$$p_w = A_s/(b_w*d) = 0.00331157$$

$$A_s \text{ (tension reinf.)} = 709.9999$$

bw = 400.00
d = 536.00
 $V_u \cdot d / \mu_u < 1 = 1.00$
 $\mu_u = 1.0197E+006$
 $V_u = 9840.632$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 349068.643$

$V_{s1} = 311834.654$ is calculated for jacket, with:

d = 536.00
 $A_v = 157079.633$
 $f_y = 555.56$
s = 150.00

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 37233.989$ is calculated for jacket, with:

d = 400.00
 $A_v = 100530.965$
 $f_y = 555.56$
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: $V_s + V_f \leq 818179.336$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 0.85$
Mean strength values are used for both shear and moment calculations.
Consequently:

Jacket
New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$

Existing Column
New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$
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, $f_s = 1.25 \cdot f_{sm} = 694.45$
Existing Column
New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 694.45$

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00

Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00

Primary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with $l_o/l_{ou,min} = 0.30$
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = -3.1831679E-014$
EDGE -B-
Shear Force, $V_b = 3.1831679E-014$
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: $As_{,ten} = 911.0619$
-Compression: $As_{,com} = 911.0619$
-Middle: $As_{,mid} = 556.0619$

Calculation of Shear Capacity ratio , $V_e/V_r = 0.26755321$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n / 2 = 102534.798$
with
 $M_{pr1} = \text{Max}(M_{u1+} , M_{u1-}) = 1.5380E+008$
 $M_{u1+} = 1.5380E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
 $M_{u1-} = 1.5380E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(M_{u2+} , M_{u2-}) = 1.5380E+008$
 $M_{u2+} = 1.5380E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
 $M_{u2-} = 1.5380E+008$, 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
 $V_1 = -3.1831679E-014$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 3.1831679E-014$, 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:
 $\phi_u = 1.7246351E-005$
 $M_u = 1.5380E+008$

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 : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_c, \phi_{cc}) = 0.00514506$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\phi_u = 0.00514506$
 w_e (5.4c) = 0.00169139
 a_{se} ((5.4d), TBDY) = $(a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int}) / A_{sec} = 0.14776895$

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) = 1.25908

Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25223
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25908
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 0.30

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by 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 = 389.0139

with Es1 = (Esjacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.30

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of $es_{u2_nominal}$ and y_2 , sh_2, ft_2, fy_2 , it is considered characteristic value $fs_{y2} = fs_2/1.2$, from table 5.1, TBDY.

y_1 , sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_2 = (fs_{jacket} \cdot A_{s,com,jacket} + fs_{core} \cdot A_{s,com,core}) / A_{s,com} = 389.0139$

with $Es_2 = (Es_{jacket} \cdot A_{s,com,jacket} + Es_{core} \cdot A_{s,com,core}) / A_{s,com} = 200000.00$

$y_v = 0.00140044$

$sh_v = 0.0044814$

$ft_v = 466.8167$

$fy_v = 389.0139$

$s_{uv} = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$lo/lo_{u,min} = lb/ld = 0.30$

$s_{uv} = 0.4 \cdot es_{uv_nominal} ((5.5), TBDY) = 0.032$

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 $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 389.0139$

with $Es_v = (Es_{jacket} \cdot A_{s,mid,jacket} + Es_{mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.04490101$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.04490101$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.0274051$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

$f_{cc} (5A.2, TBDY) = 33.00$

$cc (5A.5, TBDY) = 0.002$

$c = \text{confinement factor} = 1.00$

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.05384204$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.05384204$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.03286221$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$s_u (4.9) = 0.16841906$

$\mu_u = MR_c (4.14) = 1.5380E+008$

$u = s_u (4.1) = 1.7246351E-005$

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of μ_{u1} -

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:

$u = 1.7246351E-005$

$\mu_u = 1.5380E+008$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$f_c = 33.00$

$cc (5A.5, TBDY) = 0.002$

Final value of c_u : $c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00514506$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $c_u = 0.00514506$

w_e (5.4c) = 0.00169139

a_{se} ((5.4d), TBDY) = $(a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o_1} = 340.00$

$h_{o_1} = 610.00$

$b_{i2_1} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o_2} = 192.00$

$h_{o_2} = 492.00$

$b_{i2_2} = 557856.00$

$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$

Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25223$

p_{s1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$

No stirrups, $n_{s_1} = 2.00$

$h_1 = 670.00$

p_{s2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$

$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$

No stirrups, $n_{s_2} = 2.00$

$h_2 = 500.00$

 $p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25908$

p_{s1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$

$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$

No stirrups, $n_{s_1} = 2.00$

$h_1 = 400.00$

p_{s2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$

$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$

No stirrups, $n_{s_2} = 2.00$

$h_2 = 200.00$

 $A_{sec} = 268000.00$

$s_1 = 150.00$

$s_2 = 300.00$

$f_{ywe1} = 694.45$

$f_{ywe2} = 694.45$

$f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY: $c_c = 0.002$

c = confinement factor = 1.00

$y_1 = 0.00140044$

$sh_1 = 0.0044814$

$ft_1 = 466.8167$

$fy_1 = 389.0139$

$su_1 = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$l_o / l_{ou, \min} = l_b / l_d = 0.30$

$su_1 = 0.4 * e_{su1_nominal}$ ((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 $f_{sy1} = f_s / 1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $f_{s1} = (f_{s, \text{jacket}} * A_{s1, \text{ten, jacket}} + f_{s, \text{core}} * A_{s1, \text{ten, core}}) / A_{s1, \text{ten}} = 389.0139$

with $E_{s1} = (E_{s, \text{jacket}} * A_{s1, \text{ten, jacket}} + E_{s, \text{core}} * A_{s1, \text{ten, core}}) / A_{s1, \text{ten}} = 200000.00$

$y_2 = 0.00140044$

$sh_2 = 0.0044814$

$ft_2 = 466.8167$

$fy_2 = 389.0139$

$su_2 = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.30

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 = 389.0139

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

lo/lou,min = lb/ld = 0.30

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.04490101

2 = Asl,com/(b*d)*(fs2/fc) = 0.04490101

v = Asl,mid/(b*d)*(fsv/fc) = 0.0274051

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 33.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.05384204

2 = Asl,com/(b*d)*(fs2/fc) = 0.05384204

v = Asl,mid/(b*d)*(fsv/fc) = 0.03286221

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

v < vs,y2 - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.16841906

Mu = MRc (4.14) = 1.5380E+008

u = su (4.1) = 1.7246351E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 1.7246351E-005

Mu = 1.5380E+008

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 : $cu^* = shear_factor * Max(cu, cc) = 0.00514506$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.00514506$
 $we (5.4c) = 0.00169139$
 $ase ((5.4d), TBDY) = (ase1 * Aext + ase2 * Aint) / Asec = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = Max(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$
 $psh, min * Fywe = Min(psh, x * Fywe, psh, y * Fywe) = 1.25908$
 Expression ((5.4d), TBDY) for $psh, min * Fywe$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh_x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 2.25223$
 $ps1 (external) = (Ash1 * h1 / s1) / Asec = 0.00261799$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 (internal) = (Ash2 * h2 / s2) / Asec = 0.00062519$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.25908$
 $ps1 (external) = (Ash1 * h1 / s1) / Asec = 0.00156298$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 (internal) = (Ash2 * h2 / s2) / Asec = 0.00025008$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 694.45$
 $fywe2 = 694.45$
 $fce = 33.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = confinement\ factor = 1.00$

$y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 466.8167$
 $fy1 = 389.0139$
 $su1 = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$lo/lou, min = lb/d = 0.30$

$su1 = 0.4 * esu1_nominal ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered characteristic value $fsy1 = fs1 / 1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 * (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs, jacket * Asl, ten, jacket + fs, core * Asl, ten, core) / Asl, ten = 389.0139$

with $Es1 = (Es, jacket * Asl, ten, jacket + Es, core * Asl, ten, core) / Asl, ten = 200000.00$

$y2 = 0.00140044$

$sh_2 = 0.0044814$
 $ft_2 = 466.8167$
 $fy_2 = 389.0139$
 $su_2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lo_{min} = lb/lb_{min} = 0.30$
 $su_2 = 0.4 * esu_{2_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2_nominal} = 0.08$,
 For calculation of $esu_{2_nominal}$ and y_2 , sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} * Asl_{com,jacket} + fs_{core} * Asl_{com,core}) / Asl_{com} = 389.0139$
 with $Es_2 = (Es_{jacket} * Asl_{com,jacket} + Es_{core} * Asl_{com,core}) / Asl_{com} = 200000.00$
 $yv = 0.00140044$
 $shv = 0.0044814$
 $ftv = 466.8167$
 $fyv = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lo_{min} = lb/ld = 0.30$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and yv , shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 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 $fsv = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 389.0139$
 with $Esv = (Es_{jacket} * Asl_{mid,jacket} + Es_{mid} * Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.04490101$
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.04490101$
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.0274051$
 and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.05384204$
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.05384204$
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.03286221$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.16841906$
 $Mu = MRc (4.14) = 1.5380E+008$
 $u = su (4.1) = 1.7246351E-005$

 Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

 Calculation of Mu_2 -

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.7246351E-005$

Mu = 1.5380E+008

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: $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00514506$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $cu = 0.00514506$

we (5.4c) = 0.00169139

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

$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.25908$

Expression ((5.4d), TBDY) for $psh_{min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25223$

ps1 (external) = $(Ash1 * h1 / s1) / A_{sec} = 0.00261799$

Ash1 = $A_{stir_1} * ns_1 = 157.0796$

No stirrups, $ns_1 = 2.00$

h1 = 670.00

ps2 (internal) = $(Ash2 * h2 / s2) / A_{sec} = 0.00062519$

Ash2 = $A_{stir_2} * ns_2 = 100.531$

No stirrups, $ns_2 = 2.00$

h2 = 500.00

$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25908$

ps1 (external) = $(Ash1 * h1 / s1) / A_{sec} = 0.00156298$

Ash1 = $A_{stir_1} * ns_1 = 157.0796$

No stirrups, $ns_1 = 2.00$

h1 = 400.00

ps2 (internal) = $(Ash2 * h2 / s2) / A_{sec} = 0.00025008$

Ash2 = $A_{stir_2} * ns_2 = 100.531$

No stirrups, $ns_2 = 2.00$

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A5), TBDY), TBDY: $cc = 0.002$

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

lo/lou,min = lb/d = 0.30

su1 = $0.4 * esu1_{nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu1_{nominal} = 0.08$,

For calculation of $esu1_{nominal}$ and y1, sh1, ft1, fy1, it is considered

characteristic value $f_{s1} = f_{s1}/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $f_{s1} = (f_{s,jacket} \cdot A_{s,ten,jacket} + f_{s,core} \cdot A_{s,ten,core})/A_{s,ten} = 389.0139$

with $E_{s1} = (E_{s,jacket} \cdot A_{s,ten,jacket} + E_{s,core} \cdot A_{s,ten,core})/A_{s,ten} = 200000.00$

$y_2 = 0.00140044$

$sh_2 = 0.0044814$

$ft_2 = 466.8167$

$fy_2 = 389.0139$

$su_2 = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$l_o/l_{o,min} = l_b/l_{d,min} = 0.30$

$su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,

For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered

characteristic value $f_{s2} = f_{s2}/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $f_{s2} = (f_{s,jacket} \cdot A_{s,com,jacket} + f_{s,core} \cdot A_{s,com,core})/A_{s,com} = 389.0139$

with $E_{s2} = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core})/A_{s,com} = 200000.00$

$y_v = 0.00140044$

$sh_v = 0.0044814$

$ft_v = 466.8167$

$fy_v = 389.0139$

$su_v = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$l_o/l_{o,min} = l_b/l_d = 0.30$

$su_v = 0.4 \cdot esu_{v,nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu_{v,nominal} = 0.08$,

considering characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY

For calculation of $esu_{v,nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered

characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core})/A_{s,mid} = 389.0139$

with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core})/A_{s,mid} = 200000.00$

$1 = A_{s,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.04490101$

$2 = A_{s,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.04490101$

$v = A_{s,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.0274051$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

$f_{cc} (5A.2, TBDY) = 33.00$

$cc (5A.5, TBDY) = 0.002$

$c = \text{confinement factor} = 1.00$

$1 = A_{s,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.05384204$

$2 = A_{s,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.05384204$

$v = A_{s,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.03286221$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

---->

$su (4.9) = 0.16841906$

$Mu = MRc (4.14) = 1.5380E+008$

$u = su (4.1) = 1.7246351E-005$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 383231.42$

Calculation of Shear Strength at edge 1, $V_{r1} = 383231.42$

$V_{r1} = V_n$ ((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: $V_c = 197061.477$

= 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)

$p_w = A_s / (b_w \cdot d) = 0.00331157$

A_s (tension reinf.) = 709.9999

$b_w = 670.00$

$d = 320.00$

$V_u \cdot d / M_u < 1 = 0.00$

$M_u = 5.3381491E-011$

$V_u = 3.1831679E-014$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 186169.943$

$V_{s1} = 186169.943$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 150.00$

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:

$d_2 = 160.00$

$A_v = 100530.965$

$f_y = 555.56$

$s = 300.00$

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, $V_{r2} = 383231.42$

$V_{r2} = V_n$ ((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: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$p_w = A_s / (b_w \cdot d) = 0.00331157$

A_s (tension reinf.) = 709.9999

$b_w = 670.00$

$d = 320.00$

$V_u \cdot d / M_u < 1 = 0.00$

$M_u = 4.2118567E-011$

$V_u = 3.1831679E-014$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 186169.943$

$V_{s1} = 186169.943$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 150.00$

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:

$d = 160.00$

$A_v = 100530.965$

$f_y = 555.56$

$s = 300.00$

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, $\phi = 0.85$
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$
Existing Column
New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$
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, $L = 3000.00$
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with $l_b/l_d = 0.30$
No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 1.1047E+007$
Shear Force, $V_2 = -6.6781494E-014$
Shear Force, $V_3 = 859.8093$
Axial Force, $F = -4363.163$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 709.9999$
-Compression: $A_{sc} = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten} = 709.9999$
-Compression: $A_{sc,com} = 1266.062$
-Middle: $A_{sc,mid} = 402.1239$
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten,jacket} = 402.1239$
-Compression: $A_{sc,com,jacket} = 804.2477$
-Middle: $A_{sc,mid,jacket} = 402.1239$
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten,core} = 307.8761$
-Compression: $A_{sc,com,core} = 461.8141$
-Middle: $A_{sc,mid,core} = 0.00$
Mean Diameter of Tension Reinforcement, $DbL = 15.00$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_{,R} = 1.0^* u = 0.02378977$
 $u = y + p = 0.02378977$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00378977$ ((4.29), Biskinis Phd)
 $M_y = 1.5387E+008$
 $L_s = M/V$ (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 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 3.0467102E-006$
with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b / d)^{2/3}) = 311.2112$
 $d = 627.00$
 $y = 0.18543366$
 $A = 0.0095383$
 $B = 0.0040897$
with $p_t = 0.00283094$
 $p_c = 0.00504809$
 $p_v = 0.00160336$
 $N = 4363.163$
 $b = 400.00$
 $" = 0.06858054$
 $y_{comp} = 1.9036375E-005$
with $f_c = 33.00$
 $E_c = 26999.444$
 $y = 0.18432312$
 $A = 0.00944286$
 $B = 0.0040338$
with $E_s = 200000.00$

Calculation of ratio l_b / d

Inadequate Lap Length with $l_b / d = 0.30$

- Calculation of p -

From table 10-7: $p = 0.02$

with:

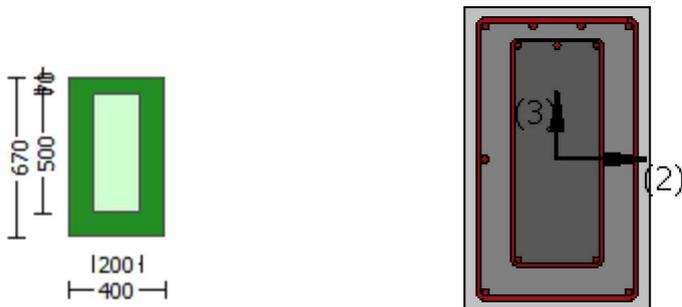
- Condition iv occurred
Beam controlled by inadequate embedment into beam-column joint:
($l_b / d < 1$ and With Lapping in the Vicinity of the End Regions)
- Condition i occurred
Beam controlled by flexure: $V_p / V_o \leq 1$
shear control ratio $V_p / V_o = 0.44897845$
- Transverse Reinforcement: C
- Stirrup Spacing $\leq d / 3$
- Low ductility demand, $\gamma / y < 2$ (table 10-6, ASCE 41-17)
 $= 6.1434074E-005$
- Stirrup Spacing $\leq d / 2$
 $d = d_{external} = 627.00$
 $s = s_{external} = 150.00$
- Strength provided by hoops $V_s < 3/4 * \text{design Shear}$
 $V_s = 386302.632$, already given in calculation of shear control ratio
design Shear = 859.8093

$\rho = A_{st}/(b_w*d) = 0.00283094$
 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: $\rho_{bal} = 0.01704017$
 $f_c = (f_{c_jacket}*Area_jacket + f_{c_core}*Area_core)/section_area = 33.00$
 $f_y = f_{y_jacket_bars} = 555.56$
 From 10.2.7.3, ACI 318-11: $\lambda = 1 = 0.65$
 From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000/(87000 + f_y) = c_b/dt = 0.003/(0.003 + \lambda \rho) = 0.51922877$
 $\lambda \rho = 0.0027778$
 $V/(b_w*d*f_c^{0.5}) = 0.00718689$, 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, $\gamma = 0.85$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$

New material of Primary 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 Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$

New material of Primary 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, $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{ou,min} = l_b/l_d = 0.30$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 1.1047E+007$

Shear Force, $V_a = 859.8093$

EDGE -B-

Bending Moment, $M_b = 1.5895E+007$

Shear Force, $V_b = 18821.457$

BOTH EDGES

Axial Force, $F = -4363.163$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 709.9999$

-Compression: $A_{sc} = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{st,ten} = 709.9999$

-Compression: $A_{sl,com} = 1266.062$

-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 $V_R = 1.0 \cdot V_n = 486182.787$

V_n ((22.5.1.1), ACI 318-14) = 486182.787

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: $V_c = 172023.522$

= 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)

$p_w = A_s / (b_w \cdot d) = 0.00331157$

A_s (tension reinf.) = 709.9999

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / M_u < 1 = 0.04171681$

$M_u = 1.1047E+007$

$V_u = 859.8093$

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

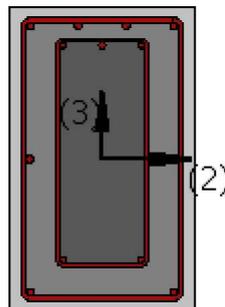
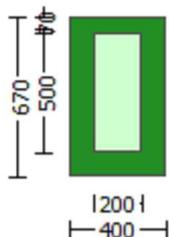
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

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, $\gamma = 0.85$
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$
Existing Column
New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$
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, $f_s = 1.25 \cdot f_{sm} = 694.45$
Existing Column
New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 694.45$

External Height, $H = 670.00$
External Width, $W = 400.00$
Internal Height, $H = 500.00$
Internal Width, $W = 200.00$
Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.00
Element Length, $L = 3000.00$
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with $l_o/l_{o,min} = 0.30$
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, $V_a = 9840.634$
EDGE -B-
Shear Force, $V_b = 9840.632$
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, $V_e/V_r = 0.44897845$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 250619.824$
with
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 3.6117E+008$
 $Mu_{1+} = 2.1156E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
 $Mu_{1-} = 3.6117E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 3.6117E+008$

Mu2+ = 2.1156E+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- = 3.6117E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination
and

$$\pm wu*ln = (|V1| + |V2|)/2$$

with

V1 = 9840.634, is the shear force acting at edge 1 for the the static loading combination

V2 = 9840.632, is the shear force acting at edge 2 for the the static loading combination

Calculation of Mu1+

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 9.5303512E-006$$

$$Mu = 2.1156E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$fc = 33.00$$

$$co \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.00514506$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.00514506$$

$$w_e \text{ (5.4c)} = 0.00169139$$

$$ase \text{ ((5.4d), TBDY)} = (ase1*A_{ext} + ase2*A_{int})/A_{sec} = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

$$psh_{min}*Fy_{we} = \text{Min}(psh_x*Fy_{we}, psh_y*Fy_{we}) = 1.25908$$

Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$psh_x*Fy_{we} = psh1*Fy_{we1} + ps2*Fy_{we2} = 2.25223$$

$$ps1 \text{ (external)} = (Ash1*h1/s1)/A_{sec} = 0.00261799$$

$$Ash1 = Astir_1*ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (Ash2*h2/s2)/A_{sec} = 0.00062519$$

$$Ash2 = Astir_2*ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y*Fy_{we} = psh1*Fy_{we1} + ps2*Fy_{we2} = 1.25908$$

$$ps1 \text{ (external)} = (Ash1*h1/s1)/A_{sec} = 0.00156298$$

$$Ash1 = Astir_1*ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2*h2/s2)/A_{sec} = 0.00025008$$

$$Ash2 = Astir_2*ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

fywe1 = 694.45
fywe2 = 694.45
fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00

y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 0.30

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.30

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 0.30

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.03337198

2 = Asl,com/(b*d)*(fs2/fc) = 0.05950845

v = Asl,mid/(b*d)*(fsv/fc) = 0.01890095

and confined core properties:

b = 340.00
d = 597.00
d' = 13.00

fcc (5A.2, TBDY) = 33.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.04123408

2 = Asl,com/(b*d)*(fs2/fc) = 0.07352802

v = Asl,mid/(b*d)*(fsv/fc) = 0.02335381

Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.14317227
Mu = MRc (4.14) = 2.1156E+008
u = su (4.1) = 9.5303512E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 9.8792908E-006
Mu = 3.6117E+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) = 0.00514506
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00514506
we (5.4c) = 0.00169139
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) = 1.25908
Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25223
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 = 1.25908
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 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 0.30

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.30

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 0.30

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.05950845

2 = Asl,com/(b*d)*(fs2/fc) = 0.03337198

v = Asl,mid/(b*d)*(fsv/fc) = 0.01890095

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 33.00

$$cc \text{ (5A.5, TBDY)} = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.07352802$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.04123408$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.02335381$$

Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$su \text{ (4.9)} = 0.17343568$$

$$\mu_u = M_{Rc} \text{ (4.14)} = 3.6117E+008$$

$$u = su \text{ (4.1)} = 9.8792908E-006$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_{u2+}

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 9.5303512E-006$$

$$\mu_u = 2.1156E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$co \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00514506$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } cu = 0.00514506$$

$$w_e \text{ (5.4c)} = 0.00169139$$

$$ase \text{ ((5.4d), TBDY)} = (ase1*A_{ext} + ase2*A_{int})/A_{sec} = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

$$psh_{min}*F_{ywe} = \text{Min}(psh_x*F_{ywe}, psh_y*F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for $psh_{min}*F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$psh_x*F_{ywe} = psh1*F_{ywe1} + ps2*F_{ywe2} = 2.25223$$

$$ps1 \text{ (external)} = (A_{sh1}*h1/s1)/A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1}*ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (A_{sh2}*h2/s2)/A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2}*ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y*F_{ywe} = psh1*F_{ywe1} + ps2*F_{ywe2} = 1.25908$$

$$ps1 \text{ (external)} = (A_{sh1}*h1/s1)/A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1}*ns_1 = 157.0796$$

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, $ns_2 = 2.00$
 $h2 = 200.00$

 $Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 694.45$
 $fywe2 = 694.45$
 $fce = 33.00$

From ((5.A.5), TBDY), TBDY: $cc = 0.002$
 $c =$ confinement factor = 1.00

$y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 466.8167$
 $fy1 = 389.0139$
 $su1 = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$lo/lou,min = lb/ld = 0.30$

$su1 = 0.4*esu1_nominal$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139$

with $Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$

$y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 466.8167$
 $fy2 = 389.0139$
 $su2 = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$lo/lou,min = lb/lb,min = 0.30$

$su2 = 0.4*esu2_nominal$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139$

with $Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$

$yv = 0.00140044$
 $shv = 0.0044814$
 $ftv = 466.8167$
 $fyv = 389.0139$
 $suv = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$lo/lou,min = lb/ld = 0.30$

$suv = 0.4*esuv_nominal$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esuv_nominal = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139$

with $Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$

$1 = Asl,ten/(b*d)*(fs1/fc) = 0.03337198$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.05950845$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.01890095$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 33.00$$

$$cc (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.04123408$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.07352802$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.02335381$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.14317227$$

$$\mu_u = M_{Rc} (4.14) = 2.1156E+008$$

$$u = s_u (4.1) = 9.5303512E-006$$

Calculation of ratio l_b/d

Inadequate Lap Length with $l_b/d = 0.30$

Calculation of μ_{u2} -

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 9.8792908E-006$$

$$\mu_u = 3.6117E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o (5A.5, TBDY) = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00514506$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00514506$$

$$w_e (5.4c) = 0.00169139$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for $p_{sh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25223$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25908
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 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 0.30

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.30

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 0.30

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered

characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with $f_{sv} = (f_s \cdot j_{\text{jacket}} \cdot A_{s,\text{mid,jacket}} + f_s \cdot \text{mid} \cdot A_{s,\text{mid,core}}) / A_{s,\text{mid}} = 389.0139$
 with $E_{sv} = (E_s \cdot j_{\text{jacket}} \cdot A_{s,\text{mid,jacket}} + E_s \cdot \text{mid} \cdot A_{s,\text{mid,core}}) / A_{s,\text{mid}} = 200000.00$
 $1 = A_{s,\text{ten}} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.05950845$
 $2 = A_{s,\text{com}} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.03337198$
 $v = A_{s,\text{mid}} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.01890095$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} \text{ (5A.2, TBDY)} = 33.00$
 $cc \text{ (5A.5, TBDY)} = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{s,\text{ten}} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.07352802$
 $2 = A_{s,\text{com}} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.04123408$
 $v = A_{s,\text{mid}} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02335381$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$su \text{ (4.9)} = 0.17343568$
 $\mu = MR_c \text{ (4.14)} = 3.6117E+008$
 $u = su \text{ (4.1)} = 9.8792908E-006$

 Calculation of ratio l_b/d

 Inadequate Lap Length with $l_b/d = 0.30$

 Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 558200.119$

 Calculation of Shear Strength at edge 1, $V_{r1} = 558200.119$
 $V_{r1} = V_n \text{ ((22.5.1.1), ACI 318-14)}$

 NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

 From Table (22.5.5.1), ACI 318-14: $V_c = 209131.476$
 $= 1$ (normal-weight concrete)
 Mean concrete strength: $f'_c = (f'_c \cdot j_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c \cdot \text{core} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 33.00$, but $f'_c^{0.5} \leq 8.3$
 MPa (22.5.3.1, ACI 318-14)

$p_w = A_s / (b_w \cdot d) = 0.00331157$
 $A_s \text{ (tension reinf.)} = 709.9999$
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu < 1 = 1.00$
 $\mu = 1.0197E+006$
 $V_u = 9840.634$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 349068.643$

$V_{s1} = 311834.654$ is calculated for jacket, with:

$d = 536.00$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 37233.989$ is calculated for jacket, with:

$d_2 = 400.00$
 $A_v = 100530.965$
 $f_y = 555.56$
 $s = 300.00$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$
 $V_f \text{ ((11-3)-(11.4), ACI 440)} = 0.00$

From (11-11), ACI 440: $V_s + V_f \leq 818179.336$

Calculation of Shear Strength at edge 2, Vr2 = 558200.119
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 = 9840.632
From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 349068.643
Vs1 = 311834.654 is calculated for jacket, with:
d = 536.00
Av = 157079.633
fy = 555.56
s = 150.00
Vs1 has been multiplied by 1 (s < d/2, according to ASCE 41-17,10.3.4)
Vs2 = 37233.989 is calculated for jacket, with:
d = 400.00
Av = 100530.965
fy = 555.56
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, = 0.85
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
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 = 694.45
Existing Column

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 694.45$

External Height, $H = 670.00$
External Width, $W = 400.00$
Internal Height, $H = 500.00$
Internal Width, $W = 200.00$
Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.00
Element Length, $L = 3000.00$
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with $l_o/l_{ou,min} = 0.30$
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = -3.1831679E-014$
EDGE -B-
Shear Force, $V_b = 3.1831679E-014$
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 , $V_e/V_r = 0.26755321$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n / 2 = 102534.798$
with
 $M_{pr1} = \text{Max}(Mu_{1+} , Mu_{1-}) = 1.5380E+008$
 $Mu_{1+} = 1.5380E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
 $Mu_{1-} = 1.5380E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(Mu_{2+} , Mu_{2-}) = 1.5380E+008$
 $Mu_{2+} = 1.5380E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
 $Mu_{2-} = 1.5380E+008$, 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
 $V_1 = -3.1831679E-014$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 3.1831679E-014$, 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:
 $\phi_u = 1.7246351E-005$
 $Mu = 1.5380E+008$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$fc = 33.00$$

$$co (5A.5, TBDY) = 0.002$$

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00514506$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } cu = 0.00514506$$

$$we (5.4c) = 0.00169139$$

$$ase ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

$$psh_{,min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for $psh_{,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25223$$

$$ps1 \text{ (external)} = (Ash1 * h1 / s1) / A_{sec} = 0.00261799$$

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (Ash2 * h2 / s2) / A_{sec} = 0.00062519$$

$$Ash2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25908$$

$$ps1 \text{ (external)} = (Ash1 * h1 / s1) / A_{sec} = 0.00156298$$

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 * h2 / s2) / A_{sec} = 0.00025008$$

$$Ash2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 694.45$$

$$fce = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.00140044$$

$$sh1 = 0.0044814$$

$$ft1 = 466.8167$$

$$fy1 = 389.0139$$

$$su1 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$lo/lou_{,min} = lb/d = 0.30$$

$$su1 = 0.4 * esu1_{nominal} ((5.5), TBDY) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu1_{nominal} = 0.08,$$

For calculation of $esu1_{nominal}$ and $y1, sh1, ft1, fy1$, it is considered characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $f_{s1} = (f_{s,jacket} \cdot A_{s,ten,jacket} + f_{s,core} \cdot A_{s,ten,core}) / A_{s,ten} = 389.0139$
 with $E_{s1} = (E_{s,jacket} \cdot A_{s,ten,jacket} + E_{s,core} \cdot A_{s,ten,core}) / A_{s,ten} = 200000.00$
 $y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 466.8167$
 $fy_2 = 389.0139$
 $su_2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_0/l_{ou,min} = l_b/l_{b,min} = 0.30$
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $f_{sy2} = f_{s2}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{s2} = (f_{s,jacket} \cdot A_{s,com,jacket} + f_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 389.0139$
 with $E_{s2} = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $su_v = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_0/l_{ou,min} = l_b/l_d = 0.30$
 $su_v = 0.4 \cdot esu_{v,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{v,nominal} = 0.08$,
 considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $esu_{v,nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 389.0139$
 with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.04490101$
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.04490101$
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.0274051$
 and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.05384204$
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.05384204$
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.03286221$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.16841906$
 $Mu = MRc (4.14) = 1.5380E+008$
 $u = su (4.1) = 1.7246351E-005$

 Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Mu_1 -

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 1.7246351E-005$$

$$Mu = 1.5380E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o(5A.5, TBDY) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.00514506$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.00514506$$

$$w_e(5.4c) = 0.00169139$$

$$a_{se}((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for $p_{sh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25223$$

$$p_{s1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

No stirrups, $n_{s_1} = 2.00$

$$h_1 = 670.00$$

$$p_{s2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

No stirrups, $n_{s_2} = 2.00$

$$h_2 = 500.00$$

$$p_{sh,y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25908$$

$$p_{s1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

No stirrups, $n_{s_1} = 2.00$

$$h_1 = 400.00$$

$$p_{s2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

No stirrups, $n_{s_2} = 2.00$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o / l_{ou,min} = l_b / d = 0.30$$

$$su1 = 0.4 * esu1_nominal ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs1 = (fs_jacket * Asl,ten,jacket + fs_core * Asl,ten,core) / Asl,ten = 389.0139$$

$$\text{with } Es1 = (Es_jacket * Asl,ten,jacket + Es_core * Asl,ten,core) / Asl,ten = 200000.00$$

$$y2 = 0.00140044$$

$$sh2 = 0.0044814$$

$$ft2 = 466.8167$$

$$fy2 = 389.0139$$

$$su2 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$ and also multiplied by the $shear_factor$ according to 15.7.1.4, with $Shear_factor = 1.00$

$$lo/lou,min = lb/lb,min = 0.30$$

$$su2 = 0.4 * esu2_nominal ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

$y2, sh2, ft2, fy2$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs2 = (fs_jacket * Asl,com,jacket + fs_core * Asl,com,core) / Asl,com = 389.0139$$

$$\text{with } Es2 = (Es_jacket * Asl,com,jacket + Es_core * Asl,com,core) / Asl,com = 200000.00$$

$$yv = 0.00140044$$

$$shv = 0.0044814$$

$$ftv = 466.8167$$

$$fyv = 389.0139$$

$$suv = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$ and also multiplied by the $shear_factor$ according to 15.7.1.4, with $Shear_factor = 1.00$

$$lo/lou,min = lb/ld = 0.30$$

$$suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esuv_nominal = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

yv, shv, ftv, fyv , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = (fs_jacket * Asl,mid,jacket + fs_mid * Asl,mid,core) / Asl,mid = 389.0139$$

$$\text{with } Esv = (Es_jacket * Asl,mid,jacket + Es_mid * Asl,mid,core) / Asl,mid = 200000.00$$

$$1 = Asl,ten / (b * d) * (fs1 / fc) = 0.04490101$$

$$2 = Asl,com / (b * d) * (fs2 / fc) = 0.04490101$$

$$v = Asl,mid / (b * d) * (fsv / fc) = 0.0274051$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 33.00$$

$$cc (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = Asl,ten / (b * d) * (fs1 / fc) = 0.05384204$$

$$2 = Asl,com / (b * d) * (fs2 / fc) = 0.05384204$$

$$v = Asl,mid / (b * d) * (fsv / fc) = 0.03286221$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < vs,y2$ - LHS eq.(4.5) is satisfied

--->

$$su (4.9) = 0.16841906$$

$$Mu = MRc (4.14) = 1.5380E+008$$

$$u = su (4.1) = 1.7246351E-005$$

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Mu2+

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 1.7246351E-005$$

$$Mu = 1.5380E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$cc \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00514506$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } cu = 0.00514506$$

$$we \text{ (5.4c)} = 0.00169139$$

$$ase \text{ ((5.4d), TBDY)} = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

$$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for $psh_{min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25223$$

$$ps1 \text{ (external)} = (A_{sh1} * h1 / s1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (A_{sh2} * h2 / s2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25908$$

$$ps1 \text{ (external)} = (A_{sh1} * h1 / s1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (A_{sh2} * h2 / s2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.00140044$$

$$sh1 = 0.0044814$$

$$ft1 = 466.8167$$

$$fy1 = 389.0139$$

su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 0.30

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{d})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.30

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{d})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 0.30

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered

characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{d})^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.04490101

2 = Asl,com/(b*d)*(fs2/fc) = 0.04490101

v = Asl,mid/(b*d)*(fsv/fc) = 0.0274051

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 33.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.05384204

2 = Asl,com/(b*d)*(fs2/fc) = 0.05384204

v = Asl,mid/(b*d)*(fsv/fc) = 0.03286221

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

v < vs,y2 - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.16841906

Mu = MRc (4.14) = 1.5380E+008

u = su (4.1) = 1.7246351E-005

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_2

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\mu = 1.7246351E-005$$

$$\mu_2 = 1.5380E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu_c: \mu_c^* = \text{shear_factor} * \text{Max}(\mu_c, \mu_{cc}) = 0.00514506$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu_c = 0.00514506$$

$$\mu_{we} \text{ (5.4c)} = 0.00169139$$

$$\mu_{ase} \text{ ((5.4d), TBDY)} = (\mu_{ase1} * A_{ext} + \mu_{ase2} * A_{int}) / A_{sec} = 0.14776895$$

$$\mu_{ase1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\mu_{ase2} = \text{Max}(\mu_{ase1}, \mu_{ase2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\mu_{psh, \min} * F_{ywe} = \text{Min}(\mu_{psh, x} * F_{ywe}, \mu_{psh, y} * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for $\mu_{psh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\mu_{psh, x} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{psh2} * F_{ywe2} = 2.25223$$

$$\mu_{ps1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\mu_{ps2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\mu_{psh, y} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{psh2} * F_{ywe2} = 1.25908$$

$$\mu_{ps1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\mu_{ps2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_c = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \mu_{cc} = 0.002$$

$c = \text{confinement factor} = 1.00$
 $y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 466.8167$
 $fy1 = 389.0139$
 $su1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/ld = 0.30$
 $su1 = 0.4 * esu1_nominal ((5.5), \text{TBDY}) = 0.032$
 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.
 with $fs1 = (fs,jacket * Asl,ten,jacket + fs,core * Asl,ten,core) / Asl,ten = 389.0139$
 with $Es1 = (Es,jacket * Asl,ten,jacket + Es,core * Asl,ten,core) / Asl,ten = 200000.00$
 $y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 466.8167$
 $fy2 = 389.0139$
 $su2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/lb,min = 0.30$
 $su2 = 0.4 * esu2_nominal ((5.5), \text{TBDY}) = 0.032$
 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.
 with $fs2 = (fs,jacket * Asl,com,jacket + fs,core * Asl,com,core) / Asl,com = 389.0139$
 with $Es2 = (Es,jacket * Asl,com,jacket + Es,core * Asl,com,core) / Asl,com = 200000.00$
 $yv = 0.00140044$
 $shv = 0.0044814$
 $ftv = 466.8167$
 $fyv = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/ld = 0.30$
 $suv = 0.4 * esuv_nominal ((5.5), \text{TBDY}) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs,jacket * Asl,mid,jacket + fs,mid * Asl,mid,core) / Asl,mid = 389.0139$
 with $Es_v = (Es,jacket * Asl,mid,jacket + Es,mid * Asl,mid,core) / Asl,mid = 200000.00$
 $1 = Asl,ten / (b * d) * (fs1 / fc) = 0.04490101$
 $2 = Asl,com / (b * d) * (fs2 / fc) = 0.04490101$
 $v = Asl,mid / (b * d) * (fsv / fc) = 0.0274051$
 and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, \text{TBDY}) = 33.00$
 $cc (5A.5, \text{TBDY}) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl,ten / (b * d) * (fs1 / fc) = 0.05384204$
 $2 = Asl,com / (b * d) * (fs2 / fc) = 0.05384204$
 $v = Asl,mid / (b * d) * (fsv / fc) = 0.03286221$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.16841906
Mu = MRc (4.14) = 1.5380E+008
u = su (4.1) = 1.7246351E-005

Calculation of ratio lb/l_d

Inadequate Lap Length with lb/l_d = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 383231.42

Calculation of Shear Strength at edge 1, Vr1 = 383231.42
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 = 5.3381491E-011
Vu = 3.1831679E-014

From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 186169.943

Vs1 = 186169.943 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
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 = 555.56
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 = 383231.42

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 = 4.2118567E-011
Vu = 3.1831679E-014

From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 186169.943

Vs1 = 186169.943 is calculated for jacket, with:

d = 320.00
Av = 157079.633
fy = 555.56
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 = 555.56
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: $V_s + V_f \leq 818179.336$

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, $\phi = 0.85$

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$

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, $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_b/l_d = 0.30$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = -1.5217172E-010$

Shear Force, $V_2 = -6.6781494E-014$

Shear Force, $V_3 = 859.8093$

Axial Force, $F = -4363.163$

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: $A_{sl,mid} = 556.0619$

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten,jacket} = 603.1858$

-Compression: $A_{sl,com,jacket} = 603.1858$

-Middle: $A_{sl,mid,jacket} = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten,core} = 307.8761$

-Compression: $A_{sl,com,core} = 307.8761$

-Middle: $A_{sl,mid,core} = 153.938$

Mean Diameter of Tension Reinforcement, $DbL = 15.20$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u,R = 1.0^*$ $u = 0.02193358$

$u = y + p = 0.02193358$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00193358$ ((4.29), Biskinis Phd)

$M_y = 1.1193E+008$

$L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 1500.00

From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 2.8943E+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$

$y_{ten} = 5.6171754E-006$

with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b/d)^{2/3}) = 311.2112$

$d = 357.00$

$y = 0.22404068$

$A = 0.01000128$

$B = 0.00562873$

with $pt = 0.00380895$

$pc = 0.00380895$

$pv = 0.00232477$

$N = 4363.163$

$b = 670.00$

$" = 0.12044818$

$y_{comp} = 2.7617881E-005$

with $fc = 33.00$

$E_c = 26999.444$

$y = 0.22313775$

$A = 0.00990121$

$B = 0.00557012$

with $E_s = 200000.00$

Calculation of ratio l_b/d

Inadequate Lap Length with $l_b/d = 0.30$

- Calculation of p -

From table 10-7: $p = 0.02$

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 $V_p/V_o = 0.26755321$
- Transverse Reinforcement: NC
- Stirrup Spacing $> d/3$
- Low ductility demand, $\lambda / y < 2$ (table 10-6, ASCE 41-17)
- $= 1.3665348E-021$
- Stirrup Spacing $\leq d/2$
- $d = d_{\text{external}} = 357.00$
- $s = s_{\text{external}} = 150.00$
- Strength provided by hoops $V_s < 3/4 * \text{design Shear}$
- $V_s = 215957.134$, already given in calculation of shear control ratio
- design Shear = $6.6781494E-014$
- (-)/ bal = -0.23508921
- $= A_{st}/(b_w*d) = 0.00296835$
- 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 = 0.01704017
- $f_c = (f_{c_jacket} * \text{Area}_{jacket} + f_{c_core} * \text{Area}_{core}) / \text{section_area} = 33.00$
- $f_y = f_{y_jacket_bars} = 555.56$
- From 10.2.7.3, ACI 318-11: $\lambda = 0.65$
- From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + f_y) = c_b/dt = 0.003 / (0.003 + y) = 0.51922877$
- $y = 0.0027778$
- $V / (b_w * d * f_c^{0.5}) = 5.8530115E-019$, NOTE: units in lb & in
- $b_w = 670.00$

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 13

beam B1, Floor 1

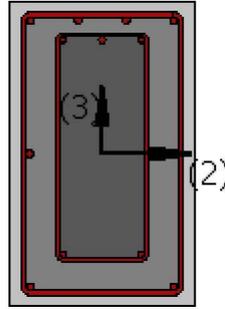
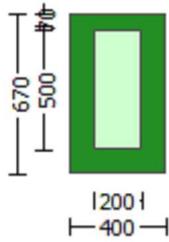
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.85$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$

New material of Primary 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 Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$

New material of Primary 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, $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{o,min} = l_b/l_d = 0.30$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = -1.5217172E-010$

Shear Force, $V_a = -6.6781494E-014$

EDGE -B-

Bending Moment, $M_b = -4.8656409E-011$

Shear Force, $V_b = 6.6781494E-014$

BOTH EDGES

Axial Force, $F = -4363.163$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 709.9999$

-Compression: $A_{sc} = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{st,ten} = 911.0619$

-Compression: $A_{st,com} = 911.0619$

-Middle: $As_{l,mid} = 556.0619$

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

$b_w = 670.00$

$d = 320.00$

$V_u \cdot d / M_u < 1 = 0.00$

$M_u = 4.8656409E-011$

$V_u = 6.6781494E-014$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 167551.608$

$V_{s1} = 167551.608$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 500.00$

$s = 150.00$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 0.00$ is calculated for core, with:

$d = 160.00$

$A_v = 100530.965$

$f_y = 500.00$

$s = 300.00$

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

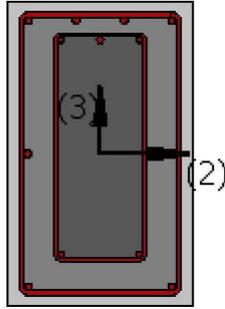
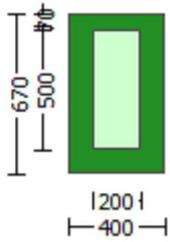
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

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, $\gamma = 0.85$
 Mean strength values are used for both shear and moment calculations.
 Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
 New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$
 Concrete Elasticity, $E_c = 26999.444$
 Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
 New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$
 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, $f_s = 1.25 \cdot f_{sm} = 694.45$

Existing Column

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 694.45$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{ou, \min} = 0.30$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 9840.634$

EDGE -B-

Shear Force, $V_b = 9840.632$

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, $V_e/V_r = 0.44897845$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 250619.824$
with
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 3.6117E+008$
 $Mu_{1+} = 2.1156E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
 $Mu_{1-} = 3.6117E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 3.6117E+008$
 $Mu_{2+} = 2.1156E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination
 $Mu_{2-} = 3.6117E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = 9840.634$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 9840.632$, is the shear force acting at edge 2 for the static loading combination

Calculation of Mu_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 9.5303512E-006$
 $M_u = 2.1156E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00027032$
 $N = 2237.255$
 $f_c = 33.00$
 $\alpha_1 (5A.5, TBDY) = 0.002$
Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00514506$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\phi_u = 0.00514506$
 $w_e (5.4c) = 0.00169139$
 $a_{se} ((5.4d), TBDY) = (a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int})/A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$
 $\text{psh}_{,min} \cdot F_{ywe} = \text{Min}(\text{psh}_{,x} \cdot F_{ywe}, \text{psh}_{,y} \cdot F_{ywe}) = 1.25908$
Expression ((5.4d), TBDY) for $\text{psh}_{,min} \cdot F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $\text{psh}_{,x} \cdot F_{ywe} = \text{psh}_1 \cdot F_{ywe1} + \text{ps}_2 \cdot F_{ywe2} = 2.25223$

ps1 (external) = $(Ash1 \cdot h1 / s1) / Asec = 0.00261799$
Ash1 = Astir_1 * ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = $(Ash2 \cdot h2 / s2) / Asec = 0.00062519$
Ash2 = Astir_2 * ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.25908
ps1 (external) = $(Ash1 \cdot h1 / s1) / Asec = 0.00156298$
Ash1 = Astir_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 * ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00

y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 0.30

su1 = $0.4 \cdot esu1_nominal$ ((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 = $(fs_jacket \cdot Asl,ten,jacket + fs_core \cdot Asl,ten,core) / Asl,ten = 389.0139$

with Es1 = $(Es_jacket \cdot Asl,ten,jacket + Es_core \cdot Asl,ten,core) / Asl,ten = 200000.00$

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.30

su2 = $0.4 \cdot esu2_nominal$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2, ft2, fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1, ft1, fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = $(fs_jacket \cdot Asl,com,jacket + fs_core \cdot Asl,com,core) / Asl,com = 389.0139$

with Es2 = $(Es_jacket \cdot Asl,com,jacket + Es_core \cdot Asl,com,core) / Asl,com = 200000.00$

yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_0/l_{ou,min} = l_b/l_d = 0.30$$

$$s_{uv} = 0.4 * e_{suv,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{suv,nominal} = 0.08$,

considering characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY

For calculation of $e_{suv,nominal}$ and γ_v , sh_v, ft_v, fy_v , it is considered

characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.

$$\gamma_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b/l_d)^{2/3}), \text{ from } 10.3.5, \text{ ASCE } 41-17.$$

$$\text{with } f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 389.0139$$

$$\text{with } E_{sv} = (E_{s,jacket} * A_{s,mid,jacket} + E_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 200000.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.03337198$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.05950845$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.01890095$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 33.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.04123408$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.07352802$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.02335381$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.14317227$$

$$M_u = M_{Rc} (4.14) = 2.1156E+008$$

$$u = s_u (4.1) = 9.5303512E-006$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of M_{u1} -

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 9.8792908E-006$$

$$M_u = 3.6117E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00514506$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00514506$$

$$\text{we (5.4c) } = 0.00169139$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o,1} = 340.00$$

$$h_{o,1} = 610.00$$

$$b_{i2,1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o,2} = 192.00$$

$$h_{o,2} = 492.00$$

$$b_{i2,2} = 557856.00$$

$$psh_{min} * Fy_{we} = \text{Min}(psh_x * Fy_{we}, psh_y * Fy_{we}) = 1.25908$$

Expression ((5.4d), TBDY) for $psh_{min} * Fy_{we}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$psh_x * Fy_{we} = psh1 * Fy_{we1} + ps2 * Fy_{we2} = 2.25223$$

$$ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00261799$$

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00062519$$

$$Ash2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y * Fy_{we} = psh1 * Fy_{we1} + ps2 * Fy_{we2} = 1.25908$$

$$ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00156298$$

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00025008$$

$$Ash2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fy_{we1} = 694.45$$

$$fy_{we2} = 694.45$$

$$fce = 33.00$$

From ((5.A5), TBDY), TBDY: $cc = 0.002$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.00140044$$

$$sh1 = 0.0044814$$

$$ft1 = 466.8167$$

$$fy1 = 389.0139$$

$$su1 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$lo/lou_{min} = lb/l_d = 0.30$$

$$su1 = 0.4 * esu1_{nominal} \text{ ((5.5), TBDY)} = 0.032$$

From table 5A.1, TBDY: $esu1_{nominal} = 0.08$,

For calculation of $esu1_{nominal}$ and $y1, sh1, ft1, fy1$, it is considered characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs1 = (fs_{jacket} * Asl_{ten,jacket} + fs_{core} * Asl_{ten,core}) / Asl_{ten} = 389.0139$$

$$\text{with } Es1 = (Es_{jacket} * Asl_{ten,jacket} + Es_{core} * Asl_{ten,core}) / Asl_{ten} = 200000.00$$

$$y2 = 0.00140044$$

$$sh2 = 0.0044814$$

$$ft2 = 466.8167$$

$$fy2 = 389.0139$$

$$su2 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$lo/lou_{min} = lb/l_{b,min} = 0.30$$

$$su2 = 0.4 * esu2_{nominal} \text{ ((5.5), TBDY)} = 0.032$$

From table 5A.1, TBDY: $esu2_{nominal} = 0.08$,

For calculation of $esu2_{nominal}$ and $y2, sh2, ft2, fy2$, it is considered characteristic value $fsy2 = fs2/1.2$, 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.

$$\text{with } fs2 = (fs_{jacket} * Asl_{com,jacket} + fs_{core} * Asl_{com,core}) / Asl_{com} = 389.0139$$

$$\text{with } Es2 = (Es_{jacket} * Asl_{com,jacket} + Es_{core} * Asl_{com,core}) / Asl_{com} = 200000.00$$

$$yv = 0.00140044$$

$$shv = 0.0044814$$

$$ftv = 466.8167$$

$f_{yv} = 389.0139$
 $s_{uv} = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $s_{uv} = 0.4 * e_{suv_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $e_{suv_nominal} = 0.08$,
 considering characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $e_{suv_nominal}$ and γ_v , sh_v, ft_v, fy_v , it is considered
 characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.
 $\gamma_1, sh_1, ft_1, fy_1$, are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 389.0139$
 with $E_{sv} = (E_{s,jacket} * A_{s,mid,jacket} + E_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 200000.00$
 $1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.05950845$
 $2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.03337198$
 $v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.01890095$
 and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.07352802$
 $2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.04123408$
 $v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.02335381$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.17343568$
 $Mu = MRc (4.14) = 3.6117E+008$
 $u = su (4.1) = 9.8792908E-006$

 Calculation of ratio l_b/l_d

 Inadequate Lap Length with $l_b/l_d = 0.30$

 Calculation of Mu_{2+}

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 9.5303512E-006$
 $Mu = 2.1156E+008$

 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 c_u : $c_u^* = \text{shear_factor} * \text{Max}(c_u, cc) = 0.00514506$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.00514506$
 $w_e (5.4c) = 0.00169139$
 $ase ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$

bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.25908

Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25223
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25908
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00

y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.30

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb,min)^ 2/3), from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.30

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb,min)^ 2/3), from 10.3.5, ASCE 41-17.

with $f_{s2} = (f_{s,jacket} \cdot A_{s1,com,jacket} + f_{s,core} \cdot A_{s1,com,core}) / A_{s1,com} = 389.0139$
 with $E_{s2} = (E_{s,jacket} \cdot A_{s1,com,jacket} + E_{s,core} \cdot A_{s1,com,core}) / A_{s1,com} = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $su_v = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 0.30$
 $su_v = 0.4 \cdot esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 389.0139$
 with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$
 $1 = A_{s1,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.03337198$
 $2 = A_{s1,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.05950845$
 $v = A_{s1,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.01890095$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{s1,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.04123408$
 $2 = A_{s1,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.07352802$
 $v = A_{s1,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02335381$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.14317227$
 $Mu = MRc (4.14) = 2.1156E+008$
 $u = su (4.1) = 9.5303512E-006$

 Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

 Calculation of Mu_2 -

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 9.8792908E-006$
 $Mu = 3.6117E+008$

 with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00027032$
 $N = 2237.255$

$f_c = 33.00$
 $cc (5A.5, TBDY) = 0.002$

Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.00514506$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.00514506$

we (5.4c) = 0.00169139
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) = 1.25908

Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25223
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25908
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 0.30

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.30

$$su_2 = 0.4 * esu_{2_nominal} ((5.5), TBDY) = 0.032$$

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 $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_2 = (fs_{jacket} * Asl_{,com,jacket} + fs_{core} * Asl_{,com,core}) / Asl_{,com} = 389.0139$$

$$\text{with } Es_2 = (Es_{jacket} * Asl_{,com,jacket} + Es_{core} * Asl_{,com,core}) / Asl_{,com} = 200000.00$$

$$y_v = 0.00140044$$

$$sh_v = 0.0044814$$

$$ft_v = 466.8167$$

$$fy_v = 389.0139$$

$$suv = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$lo/lo_{u,min} = lb/ld = 0.30$$

$$suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,

considering characteristic value $fsv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered

characteristic value $fsv = fsv/1.2$, 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.

$$\text{with } fsv = (fs_{jacket} * Asl_{,mid,jacket} + fs_{mid} * Asl_{,mid,core}) / Asl_{,mid} = 389.0139$$

$$\text{with } Es_v = (Es_{jacket} * Asl_{,mid,jacket} + Es_{mid} * Asl_{,mid,core}) / Asl_{,mid} = 200000.00$$

$$1 = Asl_{,ten} / (b * d) * (fs_1 / fc) = 0.05950845$$

$$2 = Asl_{,com} / (b * d) * (fs_2 / fc) = 0.03337198$$

$$v = Asl_{,mid} / (b * d) * (fsv / fc) = 0.01890095$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 33.00$$

$$cc (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = Asl_{,ten} / (b * d) * (fs_1 / fc) = 0.07352802$$

$$2 = Asl_{,com} / (b * d) * (fs_2 / fc) = 0.04123408$$

$$v = Asl_{,mid} / (b * d) * (fsv / fc) = 0.02335381$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied

--->

$$su (4.9) = 0.17343568$$

$$Mu = MRc (4.14) = 3.6117E+008$$

$$u = su (4.1) = 9.8792908E-006$$

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 558200.119$

Calculation of Shear Strength at edge 1, $V_{r1} = 558200.119$

$$V_{r1} = V_n ((22.5.1.1), ACI 318-14)$$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f * V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 209131.476$

= 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 (tension reinf.) = 709.9999

bw = 400.00

d = 536.00

$V_u \cdot d / \mu < 1 = 1.00$

$\mu = 1.0197E+006$

$V_u = 9840.634$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 349068.643$

$V_{s1} = 311834.654$ is calculated for jacket, with:

d = 536.00

$A_v = 157079.633$

$f_y = 555.56$

s = 150.00

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 37233.989$ is calculated for jacket, with:

d2 = 400.00

$A_v = 100530.965$

$f_y = 555.56$

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, $V_{r2} = 558200.119$

$V_{r2} = V_n$ ((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: $V_c = 209131.476$

= 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)

$p_w = A_s / (b_w \cdot d) = 0.00331157$

As (tension reinf.) = 709.9999

bw = 400.00

d = 536.00

$V_u \cdot d / \mu < 1 = 1.00$

$\mu = 1.0197E+006$

$V_u = 9840.632$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 349068.643$

$V_{s1} = 311834.654$ is calculated for jacket, with:

d = 536.00

$A_v = 157079.633$

$f_y = 555.56$

s = 150.00

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 37233.989$ is calculated for jacket, with:

d = 400.00

$A_v = 100530.965$

$f_y = 555.56$

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: $V_s + V_f \leq 818179.336$

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, $\gamma = 0.85$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$

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, $f_s = 1.25 \cdot f_{sm} = 694.45$

Existing Column

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 694.45$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{ou, \min} = 0.30$

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = -3.1831679E-014$

EDGE -B-

Shear Force, $V_b = 3.1831679E-014$

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: $A_{st, \text{ten}} = 911.0619$

-Compression: $A_{sl, \text{com}} = 911.0619$

-Middle: $A_{sl, \text{mid}} = 556.0619$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.26755321$

Member Controlled by Flexure ($V_e/V_r < 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 102534.798$

with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 1.5380E+008$

$M_{u1+} = 1.5380E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

Mu1- = 1.5380E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

Mpr2 = Max(Mu2+ , Mu2-) = 1.5380E+008

Mu2+ = 1.5380E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

Mu2- = 1.5380E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

and

$\pm wu*ln = (|V1| + |V2|)/2$

with

V1 = -3.1831679E-014, is the shear force acting at edge 1 for the the static loading combination

V2 = 3.1831679E-014, is the shear force acting at edge 2 for the the static loading combination

Calculation of Mu1+

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$\phi_u = 1.7246351E-005$

Mu = 1.5380E+008

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 ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.00514506$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\phi_u = 0.00514506$

we (5.4c) = 0.00169139

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) = 1.25908

Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25223$

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

 $psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25908$

ps1 (external) = $(Ash1*h1/s1)/Asec = 0.00156298$

Ash1 = Astir_1*ns_1 = 157.0796

No stirups, ns_1 = 2.00

h1 = 400.00

ps2 (internal) = $(Ash2*h2/s2)/Asec = 0.00025008$

Ash2 = Astir_2*ns_2 = 100.531

No stirups, ns_2 = 2.00

h2 = 200.00

$A_{sec} = 268000.00$
 $s_1 = 150.00$
 $s_2 = 300.00$
 $fy_{we1} = 694.45$
 $fy_{we2} = 694.45$
 $f_{ce} = 33.00$
 From ((5.A.5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y_1 = 0.00140044$
 $sh_1 = 0.0044814$
 $ft_1 = 466.8167$
 $fy_1 = 389.0139$
 $su_1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/ld = 0.30$
 $su_1 = 0.4 * esu_1_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_1_nominal = 0.08$,
 For calculation of $esu_1_nominal$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = (fs_jacket * A_{sl, ten, jacket} + fs_core * A_{sl, ten, core}) / A_{sl, ten} = 389.0139$
 with $Es_1 = (Es_jacket * A_{sl, ten, jacket} + Es_core * A_{sl, ten, core}) / A_{sl, ten} = 200000.00$
 $y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 466.8167$
 $fy_2 = 389.0139$
 $su_2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/lb, min = 0.30$
 $su_2 = 0.4 * esu_2_nominal ((5.5), TBDY) = 0.032$
 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 $fs_2 = (fs_jacket * A_{sl, com, jacket} + fs_core * A_{sl, com, core}) / A_{sl, com} = 389.0139$
 with $Es_2 = (Es_jacket * A_{sl, com, jacket} + Es_core * A_{sl, com, core}) / A_{sl, com} = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/ld = 0.30$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = (fs_jacket * A_{sl, mid, jacket} + fs_mid * A_{sl, mid, core}) / A_{sl, mid} = 389.0139$
 with $Es_v = (Es_jacket * A_{sl, mid, jacket} + Es_mid * A_{sl, mid, core}) / A_{sl, mid} = 200000.00$
 $1 = A_{sl, ten} / (b * d) * (fs_1 / f_c) = 0.04490101$
 $2 = A_{sl, com} / (b * d) * (fs_2 / f_c) = 0.04490101$
 $v = A_{sl, mid} / (b * d) * (fs_v / f_c) = 0.0274051$
 and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.05384204$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.05384204$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.03286221$$

Case/Assumption: Unconfined full section - Steel rupture
satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->
 μ_u (4.9) = 0.16841906
 M_u = MRc (4.14) = 1.5380E+008
 u = μ_u (4.1) = 1.7246351E-005

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_{u1} -

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 1.7246351E-005$$

$$\mu_u = 1.5380E+008$$

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 μ_{cu} : $\mu_{cu}^* = \text{shear_factor} * \text{Max}(\mu_{cu}, \mu_{cc}) = 0.00514506$
The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\mu_{cu} = 0.00514506$
 μ_{we} (5.4c) = 0.00169139
 a_{se} ((5.4d), TBDY) = $(a_{se1}*A_{ext} + a_{se2}*A_{int})/A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$

$p_{sh,min}*F_{ywe} = \text{Min}(p_{sh,x}*F_{ywe}, p_{sh,y}*F_{ywe}) = 1.25908$
Expression ((5.4d), TBDY) for $p_{sh,min}*F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x}*F_{ywe} = p_{sh1}*F_{ywe1} + p_{s2}*F_{ywe2} = 2.25223$$

$$p_{s1} \text{ (external)} = (A_{sh1}*h_1/s_1)/A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1}*n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2}*h_2/s_2)/A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2}*n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh,y}*F_{ywe} = p_{sh1}*F_{ywe1} + p_{s2}*F_{ywe2} = 1.25908$$

$$p_{s1} \text{ (external)} = (A_{sh1}*h_1/s_1)/A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1}*n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$ps_2 \text{ (internal)} = (Ash_2 * h_2 / s_2) / A_{sec} = 0.00025008$$

$$Ash_2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$fy_{we1} = 694.45$$

$$fy_{we2} = 694.45$$

$$f_{ce} = 33.00$$

From ((5.A.5), TBDY), TBDY: $cc = 0.002$

$c = \text{confinement factor} = 1.00$

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 0.30$$

$$su_1 = 0.4 * esu_{1_nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esu_{1_nominal} = 0.08$,

For calculation of $esu_{1_nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 389.0139$$

$$\text{with } Es_1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$$

$$y_2 = 0.00140044$$

$$sh_2 = 0.0044814$$

$$ft_2 = 466.8167$$

$$fy_2 = 389.0139$$

$$su_2 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 0.30$$

$$su_2 = 0.4 * esu_{2_nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esu_{2_nominal} = 0.08$,

For calculation of $esu_{2_nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $fsy_2 = fs_2 / 1.2$, from table 5.1, TBDY.

y_2, sh_2, ft_2, fy_2 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 389.0139$$

$$\text{with } Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$$

$$y_v = 0.00140044$$

$$sh_v = 0.0044814$$

$$ft_v = 466.8167$$

$$fy_v = 389.0139$$

$$suv = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 0.30$$

$$suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esuv_nominal = 0.08$,

considering characteristic value $fsyv = fsv / 1.2$, from table 5.1, TBDY
For calculation of $esuv_nominal$ and y_v, sh_v, ft_v, fy_v , it is considered
characteristic value $fsyv = fsv / 1.2$, from table 5.1, TBDY.

y_v, sh_v, ft_v, fy_v , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 389.0139$$

$$\text{with } Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$$

$$1 = A_{sl,ten} / (b * d) * (fs_1 / f_c) = 0.04490101$$

$$2 = A_{sl,com} / (b * d) * (fs_2 / f_c) = 0.04490101$$

$$v = A_{sl,mid} / (b * d) * (fsv / f_c) = 0.0274051$$

and confined core properties:

$$b = 610.00$$

$d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.05384204$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.05384204$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.03286221$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.16841906$
 $Mu = MRc (4.14) = 1.5380E+008$
 $u = su (4.1) = 1.7246351E-005$

 Calculation of ratio l_b/l_d

 Inadequate Lap Length with $l_b/l_d = 0.30$

 Calculation of Mu_{2+}

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.7246351E-005$
 $Mu = 1.5380E+008$

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 : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00514506$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.00514506$
 $we (5.4c) = 0.00169139$
 $ase ((5.4d), TBDY) = (ase1*A_{ext} + ase2*A_{int})/A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$

$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.25908$
 Expression ((5.4d), TBDY) for $psh_{min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25223$
 $ps1 (external) = (A_{sh1} * h1 / s1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 (internal) = (A_{sh2} * h2 / s2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25908
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 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 0.30

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by 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 = 389.0139

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.30

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 0.30

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.04490101$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.04490101$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.0274051$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 33.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.05384204$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.05384204$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.03286221$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.16841906$$

$$\mu_u = M_{Rc} (4.14) = 1.5380E+008$$

$$u = s_u (4.1) = 1.7246351E-005$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_{u2} -

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 1.7246351E-005$$

$$\mu_u = 1.5380E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00514506$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00514506$$

$$w_e (5.4c) = 0.00169139$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for $p_{sh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25223$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$ps_2 \text{ (internal)} = (Ash_2 * h_2 / s_2) / A_{sec} = 0.00062519$$

$$Ash_2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h_2 = 500.00$$

$$psh_y * Fy_{we} = psh_1 * Fy_{we1} + ps_2 * Fy_{we2} = 1.25908$$

$$ps_1 \text{ (external)} = (Ash_1 * h_1 / s_1) / A_{sec} = 0.00156298$$

$$Ash_1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h_1 = 400.00$$

$$ps_2 \text{ (internal)} = (Ash_2 * h_2 / s_2) / A_{sec} = 0.00025008$$

$$Ash_2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$fy_{we1} = 694.45$$

$$fy_{we2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \text{min} = lb/ld = 0.30$$

$$su_1 = 0.4 * esu_1 \text{ nominal ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu_1 \text{ nominal} = 0.08,$$

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.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 389.0139$$

$$\text{with } Es_1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$$

$$y_2 = 0.00140044$$

$$sh_2 = 0.0044814$$

$$ft_2 = 466.8167$$

$$fy_2 = 389.0139$$

$$su_2 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \text{min} = lb/lb, \text{min} = 0.30$$

$$su_2 = 0.4 * esu_2 \text{ nominal ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu_2 \text{ nominal} = 0.08,$$

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.

$$y_2, sh_2, ft_2, fy_2, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 389.0139$$

$$\text{with } Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$$

$$y_v = 0.00140044$$

$$sh_v = 0.0044814$$

$$ft_v = 466.8167$$

$$fy_v = 389.0139$$

$$suv = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \text{min} = lb/ld = 0.30$$

$$suv = 0.4 * esuv \text{ nominal ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esuv \text{ nominal} = 0.08,$$

considering characteristic value $fsyv = fsv / 1.2$, from table 5.1, TBDY

For calculation of $e_{suv_nominal}$ and y_v , sh_v , ft_v , fy_v , it is considered characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.

y_1 , sh_1 , ft_1 , fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 389.0139$

with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.04490101$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.04490101$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.0274051$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

f_{cc} (5A.2, TBDY) = 33.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.05384204$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.05384204$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.03286221$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.16841906

μ = MRc (4.14) = 1.5380E+008

$u = su$ (4.1) = 1.7246351E-005

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 383231.42$

Calculation of Shear Strength at edge 1, $V_{r1} = 383231.42$

$V_{r1} = V_n$ ((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

$b_w = 670.00$

$d = 320.00$

$V_u \cdot d / \mu < 1 = 0.00$

$\mu = 5.3381491E-011$

$V_u = 3.1831679E-014$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 186169.943$

$V_{s1} = 186169.943$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 150.00$

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:

$d_2 = 160.00$

$A_v = 100530.965$

$f_y = 555.56$

$s = 300.00$

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: Vs + Vf <= 818179.336

Calculation of Shear Strength at edge 2, Vr2 = 383231.42
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 = 4.2118567E-011
Vu = 3.1831679E-014

From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 186169.943
Vs1 = 186169.943 is calculated for jacket, with:

d = 320.00
Av = 157079.633
fy = 555.56
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 = 555.56
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: (b)
Section Type: rcjars

Constant Properties

Knowledge Factor, = 0.85
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:

Jacket
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
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, $L = 3000.00$
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with $l_b/l_d = 0.30$
No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 1.5895E+007$
Shear Force, $V2 = 6.6781494E-014$
Shear Force, $V3 = 18821.457$
Axial Force, $F = -4363.163$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 709.9999$
-Compression: $A_{sc} = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten} = 709.9999$
-Compression: $A_{sc,com} = 1266.062$
-Middle: $A_{sc,mid} = 402.1239$
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten,jacket} = 402.1239$
-Compression: $A_{sc,com,jacket} = 804.2477$
-Middle: $A_{sc,mid,jacket} = 402.1239$
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten,core} = 307.8761$
-Compression: $A_{sc,com,core} = 461.8141$
-Middle: $A_{sc,mid,core} = 0.00$
Mean Diameter of Tension Reinforcement, $D_bL = 15.00$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u,R = 1.0^*$ $u = 0.02053343$
 $u = y + p = 0.02053343$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00053343$ ((4.29), Biskinis Phd)
 $M_y = 1.5387E+008$
 $L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 844.536
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 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 3.0467102E-006$
with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b/l_d)^{2/3}) = 311.2112$
 $d = 627.00$
 $y = 0.18543366$
 $A = 0.0095383$
 $B = 0.0040897$
with $pt = 0.00283094$
 $pc = 0.00504809$
 $p_v = 0.00160336$
 $N = 4363.163$
 $b = 400.00$
 $" = 0.06858054$

y_comp = 1.9036375E-005
with fc = 33.00
Ec = 26999.444
y = 0.18432312
A = 0.00944286
B = 0.0040338
with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

- Calculation of ρ -

From table 10-7: $\rho = 0.02$

with:

- Condition iv occurred

Beam controlled by inadequate embedment into beam-column joint:
(lb/ld < 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 $V_p/V_o = 0.44897845$

- Transverse Reinforcement: C

- Stirrup Spacing $\leq d/3$

- Low ductility demand, $\rho / \rho_y < 2$ (table 10-6, ASCE 41-17)

= 9.5932707E-006

- 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

$V_s = 386302.632$, already given in calculation of shear control ratio

design Shear = 18821.457

- ($\rho - \rho'$)/ bal = -0.22420649

= $A_{st}/(b_w*d) = 0.00283094$

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 = 0.01704017

fc = $(f_{c_jacket}*Area_jacket + f_{c_core}*Area_core)/section_area = 33.00$

fy = $f_{y_jacket_bars} = 555.56$

From 10.2.7.3, ACI 318-11: $\rho_1 = 0.65$

From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + \rho) = 0.51922877$

$\rho = 0.0027778$

- $V/(b_w*d*f_c^{0.5}) = 0.15732291$, 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

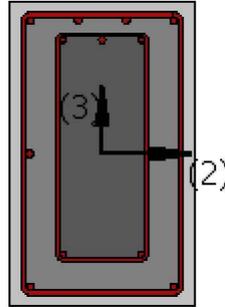
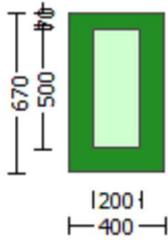
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.85$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$

New material of Primary 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 Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$

New material of Primary 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, $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{ou,min} = l_b/l_d = 0.30$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 1.1047E+007$
Shear Force, $V_a = 859.8093$
EDGE -B-
Bending Moment, $M_b = 1.5895E+007$
Shear Force, $V_b = 18821.457$
BOTH EDGES
Axial Force, $F = -4363.163$
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 $V_R = 1.0 \cdot V_n = 493339.707$
 V_n ((22.5.1.1), ACI 318-14) = 493339.707

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: $V_c = 179180.442$
= 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
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu < 1 = 0.63466799$
 $\mu = 1.5895E+007$
 $V_u = 18821.457$
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: (b)

Calculation No. 16

beam B1, Floor 1

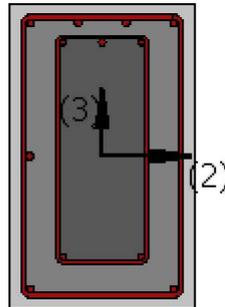
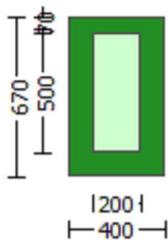
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (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, $\gamma = 0.85$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$

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, $f_s = 1.25 \cdot f_{sm} = 694.45$

Existing Column

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 694.45$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.00
Element Length, $L = 3000.00$
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with $l_o/l_{o,min} = 0.30$
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, $V_a = 9840.634$
EDGE -B-
Shear Force, $V_b = 9840.632$
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: $A_{st,ten} = 709.9999$
-Compression: $A_{sc,com} = 1266.062$
-Middle: $A_{st,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.44897845$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 250619.824$
with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 3.6117E+008$
 $\mu_{u1+} = 2.1156E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{u1-} = 3.6117E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 3.6117E+008$
 $\mu_{u2+} = 2.1156E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{u2-} = 3.6117E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = 9840.634$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 9840.632$, is the shear force acting at edge 2 for the static loading combination

Calculation of μ_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 9.5303512E-006$
 $\mu_u = 2.1156E+008$

with full section properties:
 $b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00027032$
 $N = 2237.255$

$$f_c = 33.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } c_u = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00514506$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00514506$$

$$w_e \text{ (5.4c)} = 0.00169139$$

$$\text{ase ((5.4d), TBDY)} = (\text{ase1} * A_{\text{ext}} + \text{ase2} * A_{\text{int}}) / A_{\text{sec}} = 0.14776895$$

$$\text{ase1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\text{ase2} = \text{Max}(\text{ase1}, \text{ase2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\text{psh, min} * F_{ywe} = \text{Min}(\text{psh, x} * F_{ywe}, \text{psh, y} * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for psh, min * F_{ywe} has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\text{psh, x} * F_{ywe} = \text{psh1} * F_{ywe1} + \text{ps2} * F_{ywe2} = 2.25223$$

$$\text{ps1 (external)} = (A_{sh1} * h_1 / s_1) / A_{\text{sec}} = 0.00261799$$

$$A_{sh1} = A_{\text{stir_1}} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\text{ps2 (internal)} = (A_{sh2} * h_2 / s_2) / A_{\text{sec}} = 0.00062519$$

$$A_{sh2} = A_{\text{stir_2}} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\text{psh, y} * F_{ywe} = \text{psh1} * F_{ywe1} + \text{ps2} * F_{ywe2} = 1.25908$$

$$\text{ps1 (external)} = (A_{sh1} * h_1 / s_1) / A_{\text{sec}} = 0.00156298$$

$$A_{sh1} = A_{\text{stir_1}} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\text{ps2 (internal)} = (A_{sh2} * h_2 / s_2) / A_{\text{sec}} = 0.00025008$$

$$A_{sh2} = A_{\text{stir_2}} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{\text{sec}} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A.5), TBDY), TBDY: } c_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o / l_{o, \text{min}} = l_b / l_d = 0.30$$

$$su_1 = 0.4 * e_{su1_nominal} \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } e_{su1_nominal} = 0.08,$$

For calculation of e_{su1_nominal} and y₁, sh₁, ft₁, fy₁, it is considered characteristic value fs₁ = fs₁/1.2, from table 5.1, TBDY.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b / l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 389.0139$$

$$\text{with } E_{s1} = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$$

$$y_2 = 0.00140044$$

$$sh_2 = 0.0044814$$

$$ft_2 = 466.8167$$

$$fy_2 = 389.0139$$

$$su_2 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o/l_{o,min} = l_b/l_{b,min} = 0.30$$

$$su_2 = 0.4 * esu_2_{nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esu_2_{nominal} = 0.08$,

For calculation of $esu_2_{nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 389.0139$$

$$\text{with } Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$$

$$y_v = 0.00140044$$

$$sh_v = 0.0044814$$

$$ft_v = 466.8167$$

$$fy_v = 389.0139$$

$$suv = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o/l_{o,min} = l_b/l_d = 0.30$$

$$suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,

considering characteristic value $fsv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered characteristic value $fsv = fsv/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 389.0139$$

$$\text{with } Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$$

$$1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.03337198$$

$$2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.05950845$$

$$v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.01890095$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 33.00$$

$$cc (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.04123408$$

$$2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.07352802$$

$$v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.02335381$$

Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

--->

$v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied

--->

$$su (4.9) = 0.14317227$$

$$Mu = MRc (4.14) = 2.1156E+008$$

$$u = su (4.1) = 9.5303512E-006$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Mu_1 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 9.8792908E-006$$

$$Mu = 3.6117E+008$$

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: $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00514506$
The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $cu = 0.00514506$

we (5.4c) = 0.00169139

ase ((5.4d), TBDY) = $(ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$

ase1 = 0.14776895

bo_1 = 340.00

ho_1 = 610.00

bi2_1 = 975400.00

ase2 = $\text{Max}(ase1, ase2) = 0.14776895$

bo_2 = 192.00

ho_2 = 492.00

bi2_2 = 557856.00

psh,min*Fywe = $\text{Min}(psh,x * Fywe, psh,y * Fywe) = 1.25908$

Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh_x*Fywe = $psh1 * Fywe1 + ps2 * Fywe2 = 2.25223$

ps1 (external) = $(Ash1 * h1 / s1) / A_{sec} = 0.00261799$

Ash1 = $A_{stir_1} * ns_1 = 157.0796$

No stirrups, 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 stirrups, ns_2 = 2.00

h2 = 500.00

psh_y*Fywe = $psh1 * Fywe1 + ps2 * Fywe2 = 1.25908$

ps1 (external) = $(Ash1 * h1 / s1) / A_{sec} = 0.00156298$

Ash1 = $A_{stir_1} * ns_1 = 157.0796$

No stirrups, 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 stirrups, ns_2 = 2.00

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 0.30

su1 = $0.4 * esu1_nominal$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1, ft1, fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1, ft1, fy1, are also multiplied by $\text{Min}(1, 1.25 * (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = $(fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 389.0139$

with $E_{s1} = (E_{s,jacket} \cdot A_{s,ten,jacket} + E_{s,core} \cdot A_{s,ten,core}) / A_{s,ten} = 200000.00$
 $y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 466.8167$
 $fy_2 = 389.0139$
 $su_2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_0/l_{ou,min} = l_b/l_{b,min} = 0.30$
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fs_2 = fs_2/1.2$, 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 $fs_2 = (fs_{jacket} \cdot A_{s,com,jacket} + fs_{core} \cdot A_{s,com,core}) / A_{s,com} = 389.0139$
 with $E_{s2} = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_0/l_{ou,min} = l_b/l_d = 0.30$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fs_v = fs_v/1.2$, 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 $fs_v = (fs_{jacket} \cdot A_{s,mid,jacket} + fs_{mid} \cdot A_{s,mid,core}) / A_{s,mid} = 389.0139$
 with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.05950845$
 $2 = A_{s,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.03337198$
 $v = A_{s,mid} / (b \cdot d) \cdot (fs_v / fc) = 0.01890095$
 and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.07352802$
 $2 = A_{s,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.04123408$
 $v = A_{s,mid} / (b \cdot d) \cdot (fs_v / fc) = 0.02335381$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_s, y_2$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.17343568$
 $Mu = MRc (4.14) = 3.6117E+008$
 $u = su (4.1) = 9.8792908E-006$

 Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Mu_{2+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 9.5303512E-006$$

$$\mu = 2.1156E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o(5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.00514506$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.00514506$$

$$w_e(5.4c) = 0.00169139$$

$$a_{se}((5.4d), \text{TBDY}) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25223$$

$$p_{s1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25908$$

$$p_{s1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A.5), TBDY), TBDY: } \phi_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o / l_{ou, \min} = l_b / d = 0.30$$

$$su_1 = 0.4 * e_{su1_nominal}((5.5), \text{TBDY}) = 0.032$$

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 $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs_jacket \cdot Asl,ten,jacket + fs_core \cdot Asl,ten,core) / Asl,ten = 389.0139$

with $Es1 = (Es_jacket \cdot Asl,ten,jacket + Es_core \cdot Asl,ten,core) / Asl,ten = 200000.00$

$y2 = 0.00140044$

$sh2 = 0.0044814$

$ft2 = 466.8167$

$fy2 = 389.0139$

$su2 = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$

and also multiplied by the $shear_factor$ according to 15.7.1.4, with

$Shear_factor = 1.00$

$lo/lou,min = lb/lb,min = 0.30$

$su2 = 0.4 \cdot esu2_nominal$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs2 = (fs_jacket \cdot Asl,com,jacket + fs_core \cdot Asl,com,core) / Asl,com = 389.0139$

with $Es2 = (Es_jacket \cdot Asl,com,jacket + Es_core \cdot Asl,com,core) / Asl,com = 200000.00$

$yv = 0.00140044$

$shv = 0.0044814$

$ftv = 466.8167$

$fyv = 389.0139$

$suv = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$

and also multiplied by the $shear_factor$ according to 15.7.1.4, with

$Shear_factor = 1.00$

$lo/lou,min = lb/ld = 0.30$

$suv = 0.4 \cdot esuv_nominal$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esuv_nominal = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered

characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fsv = (fs_jacket \cdot Asl,mid,jacket + fs_mid \cdot Asl,mid,core) / Asl,mid = 389.0139$

with $Es_v = (Es_jacket \cdot Asl,mid,jacket + Es_mid \cdot Asl,mid,core) / Asl,mid = 200000.00$

$1 = Asl,ten / (b \cdot d) \cdot (fs1 / fc) = 0.03337198$

$2 = Asl,com / (b \cdot d) \cdot (fs2 / fc) = 0.05950845$

$v = Asl,mid / (b \cdot d) \cdot (fsv / fc) = 0.01890095$

and confined core properties:

$b = 340.00$

$d = 597.00$

$d' = 13.00$

fcc (5A.2, TBDY) = 33.00

cc (5A.5, TBDY) = 0.002

$c =$ confinement factor = 1.00

$1 = Asl,ten / (b \cdot d) \cdot (fs1 / fc) = 0.04123408$

$2 = Asl,com / (b \cdot d) \cdot (fs2 / fc) = 0.07352802$

$v = Asl,mid / (b \cdot d) \cdot (fsv / fc) = 0.02335381$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < vs,y2$ - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.14317227

$Mu = MRc$ (4.14) = 2.1156E+008

$u = su$ (4.1) = 9.5303512E-006

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Mu2-

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\mu = 9.8792908E-006$$

$$Mu = 3.6117E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu_c, \mu_{cc}) = 0.00514506$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu_c = 0.00514506$$

$$\mu_{cc} \text{ (5.4c)} = 0.00169139$$

$$\text{ase ((5.4d), TBDY)} = (\text{ase1} * \text{Aext} + \text{ase2} * \text{Aint}) / \text{Asec} = 0.14776895$$

$$\text{ase1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\text{ase2} = \text{Max}(\text{ase1}, \text{ase2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\text{psh}_{\min} * F_{ywe} = \text{Min}(\text{psh}_{x} * F_{ywe}, \text{psh}_{y} * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for $\text{psh}_{\min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\text{psh}_{x} * F_{ywe} = \text{psh1} * F_{ywe1} + \text{ps2} * F_{ywe2} = 2.25223$$

$$\text{ps1 (external)} = (\text{Ash1} * h_1 / s_1) / \text{Asec} = 0.00261799$$

$$\text{Ash1} = \text{Astir}_1 * \text{ns}_1 = 157.0796$$

No stirrups, $\text{ns}_1 = 2.00$

$$h_1 = 670.00$$

$$\text{ps2 (internal)} = (\text{Ash2} * h_2 / s_2) / \text{Asec} = 0.00062519$$

$$\text{Ash2} = \text{Astir}_2 * \text{ns}_2 = 100.531$$

No stirrups, $\text{ns}_2 = 2.00$

$$h_2 = 500.00$$

$$\text{psh}_{y} * F_{ywe} = \text{psh1} * F_{ywe1} + \text{ps2} * F_{ywe2} = 1.25908$$

$$\text{ps1 (external)} = (\text{Ash1} * h_1 / s_1) / \text{Asec} = 0.00156298$$

$$\text{Ash1} = \text{Astir}_1 * \text{ns}_1 = 157.0796$$

No stirrups, $\text{ns}_1 = 2.00$

$$h_1 = 400.00$$

$$\text{ps2 (internal)} = (\text{Ash2} * h_2 / s_2) / \text{Asec} = 0.00025008$$

$$\text{Ash2} = \text{Astir}_2 * \text{ns}_2 = 100.531$$

No stirrups, $\text{ns}_2 = 2.00$

$$h_2 = 200.00$$

$$\text{Asec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \mu_{cc} = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_o/l_{ou,min} = l_b/l_d = 0.30$$

$$s_u1 = 0.4 * e_{su1,nominal} ((5.5), TBDY) = 0.032$$

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 $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } f_{s1} = (f_{s,jacket} * A_{s1,ten,jacket} + f_{s,core} * A_{s1,ten,core}) / A_{s1,ten} = 389.0139$$

$$\text{with } E_{s1} = (E_{s,jacket} * A_{s1,ten,jacket} + E_{s,core} * A_{s1,ten,core}) / A_{s1,ten} = 200000.00$$

$$y_2 = 0.00140044$$

$$sh_2 = 0.0044814$$

$$ft_2 = 466.8167$$

$$fy_2 = 389.0139$$

$$s_u2 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$$

$$s_u2 = 0.4 * e_{su2,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{su2,nominal} = 0.08$,

For calculation of $e_{su2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $f_{sy2} = f_{s2}/1.2$, from table 5.1, TBDY.

y_2, sh_2, ft_2, fy_2 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } f_{s2} = (f_{s,jacket} * A_{s2,com,jacket} + f_{s,core} * A_{s2,com,core}) / A_{s2,com} = 389.0139$$

$$\text{with } E_{s2} = (E_{s,jacket} * A_{s2,com,jacket} + E_{s,core} * A_{s2,com,core}) / A_{s2,com} = 200000.00$$

$$y_v = 0.00140044$$

$$sh_v = 0.0044814$$

$$ft_v = 466.8167$$

$$fy_v = 389.0139$$

$$s_uv = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_o/l_{ou,min} = l_b/l_d = 0.30$$

$$s_{uv} = 0.4 * e_{suv,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{suv,nominal} = 0.08$,

considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY

For calculation of $e_{suv,nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 389.0139$$

$$\text{with } E_{sv} = (E_{s,jacket} * A_{s,mid,jacket} + E_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 200000.00$$

$$1 = A_{s1,ten} / (b * d) * (f_{s1} / f_c) = 0.05950845$$

$$2 = A_{s2,com} / (b * d) * (f_{s2} / f_c) = 0.03337198$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.01890095$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 33.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{s1,ten} / (b * d) * (f_{s1} / f_c) = 0.07352802$$

$$2 = A_{s2,com} / (b * d) * (f_{s2} / f_c) = 0.04123408$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.02335381$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.17343568$$

$$\mu_u = M_{Rc} (4.14) = 3.6117E+008$$

$$u = s_u (4.1) = 9.8792908E-006$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 558200.119$

Calculation of Shear Strength at edge 1, $V_{r1} = 558200.119$
 $V_{r1} = V_n$ ((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: $V_c = 209131.476$
= 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
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu_u < 1 = 1.00$
 $\mu_u = 1.0197E+006$
 $V_u = 9840.634$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 349068.643$
 $V_{s1} = 311834.654$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 37233.989$ is calculated for jacket, with:
 $d_2 = 400.00$
 $A_v = 100530.965$
 $f_y = 555.56$
 $s = 300.00$
 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, $V_{r2} = 558200.119$
 $V_{r2} = V_n$ ((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: $V_c = 209131.476$
= 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
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu_u < 1 = 1.00$
 $\mu_u = 1.0197E+006$
 $V_u = 9840.632$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 349068.643$
 $V_{s1} = 311834.654$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs2 = 37233.989 is calculated for jacket, with:
d = 400.00
Av = 100530.965
fy = 555.56
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, = 0.85
Mean strength values are used for both shear and moment calculations.
Consequently:

Jacket

New material of Primary Member: Concrete Strength, fc = fcm = 33.00

New material of Primary Member: Steel Strength, fs = fsm = 555.56

Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00

Existing Column

New material of Primary Member: Concrete Strength, fc = fcm = 33.00

New material of Primary Member: Steel Strength, fs = fsm = 555.56

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 = 694.45

Existing Column

New material: Steel Strength, fs = 1.25*fsm = 694.45

#####

External Height, H = 670.00

External Width, W = 400.00

Internal Height, H = 500.00

Internal Width, W = 200.00

Cover Thickness, c = 25.00

Mean Confinement Factor overall section = 1.00

Element Length, L = 3000.00

Primary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with lo/lo,min = 0.30

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, Va = -3.1831679E-014

EDGE -B-

Shear Force, Vb = 3.1831679E-014

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: $As_{t,ten} = 911.0619$

-Compression: $As_{c,com} = 911.0619$

-Middle: $As_{mid} = 556.0619$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.26755321$

Member Controlled by Flexure ($V_e/V_r < 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 102534.798$
with

$M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 1.5380E+008$

$Mu_{1+} = 1.5380E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$Mu_{1-} = 1.5380E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

$M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 1.5380E+008$

$Mu_{2+} = 1.5380E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

$Mu_{2-} = 1.5380E+008$, 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

$V_1 = -3.1831679E-014$, is the shear force acting at edge 1 for the the static loading combination

$V_2 = 3.1831679E-014$, 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:

$\phi_u = 1.7246351E-005$

$M_u = 1.5380E+008$

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 : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00514506$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\phi_u = 0.00514506$

w_e (5.4c) = 0.00169139

ase ((5.4d), TBDY) = $(ase_1 \cdot A_{ext} + ase_2 \cdot A_{int})/A_{sec} = 0.14776895$

$ase_1 = 0.14776895$

$bo_1 = 340.00$

$ho_1 = 610.00$

$bi2_1 = 975400.00$

$ase_2 = \text{Max}(ase_1, ase_2) = 0.14776895$

$bo_2 = 192.00$

$ho_2 = 492.00$

$bi2_2 = 557856.00$

$psh_{min} \cdot F_{ywe} = \text{Min}(psh_x \cdot F_{ywe}, psh_y \cdot F_{ywe}) = 1.25908$

Expression ((5.4d), TBDY) for $psh_{min} \cdot F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25223
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 = 1.25908
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 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 0.30

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.30

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.30

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = (fsjacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.04490101

2 = Asl,com/(b*d)*(fs2/fc) = 0.04490101

v = Asl,mid/(b*d)*(fsv/fc) = 0.0274051

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 33.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.05384204

2 = Asl,com/(b*d)*(fs2/fc) = 0.05384204

v = Asl,mid/(b*d)*(fsv/fc) = 0.03286221

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

v < vs,y2 - LHS eq.(4.5) is satisfied

---->

su (4.9) = 0.16841906

Mu = MRc (4.14) = 1.5380E+008

u = su (4.1) = 1.7246351E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 1.7246351E-005

Mu = 1.5380E+008

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) = 0.00514506

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.00514506

we (5.4c) = 0.00169139

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

$$bi2_2 = 557856.00$$

$$psh_min * Fywe = \text{Min}(psh_x * Fywe, psh_y * Fywe) = 1.25908$$

Expression ((5.4d), TBDY) for $psh_min * Fywe$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$psh_x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 2.25223$$

$$ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00261799$$

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00062519$$

$$Ash2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.25908$$

$$ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00156298$$

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00025008$$

$$Ash2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 694.45$$

$$fce = 33.00$$

From ((5.A5), TBDY), TBDY: $cc = 0.002$

$c = \text{confinement factor} = 1.00$

$$y1 = 0.00140044$$

$$sh1 = 0.0044814$$

$$ft1 = 466.8167$$

$$fy1 = 389.0139$$

$$su1 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with $\text{Shear_factor} = 1.00$

$$lo/lou, \text{min} = lb/ld = 0.30$$

$$su1 = 0.4 * esu1_nominal \text{ ((5.5), TBDY)} = 0.032$$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs1 = (fs_jacket * Asl, \text{ten, jacket} + fs_core * Asl, \text{ten, core}) / Asl, \text{ten} = 389.0139$$

$$\text{with } Es1 = (Es_jacket * Asl, \text{ten, jacket} + Es_core * Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.00140044$$

$$sh2 = 0.0044814$$

$$ft2 = 466.8167$$

$$fy2 = 389.0139$$

$$su2 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with $\text{Shear_factor} = 1.00$

$$lo/lou, \text{min} = lb/lb, \text{min} = 0.30$$

$$su2 = 0.4 * esu2_nominal \text{ ((5.5), TBDY)} = 0.032$$

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

$y2, sh2, ft2, fy2$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs2 = (fs_jacket * Asl, \text{com, jacket} + fs_core * Asl, \text{com, core}) / Asl, \text{com} = 389.0139$$

$$\text{with } Es2 = (Es_jacket * Asl, \text{com, jacket} + Es_core * Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.00140044$$

$$shv = 0.0044814$$

$$ftv = 466.8167$$

$$fyv = 389.0139$$

$$suv = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lo_{u,min} = lb/ld = 0.30$$

$$suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_{nominal}$ and yv , shv , ftv , fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

$y1$, $sh1$, $ft1$, $fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 389.0139$$

$$\text{with } Es_v = (Es_{jacket} * Asl_{mid,jacket} + Es_{mid} * Asl_{mid,core}) / Asl_{mid} = 200000.00$$

$$1 = Asl_{ten} / (b * d) * (fs1 / fc) = 0.04490101$$

$$2 = Asl_{com} / (b * d) * (fs2 / fc) = 0.04490101$$

$$v = Asl_{mid} / (b * d) * (fsv / fc) = 0.0274051$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 33.00$$

$$cc (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = Asl_{ten} / (b * d) * (fs1 / fc) = 0.05384204$$

$$2 = Asl_{com} / (b * d) * (fs2 / fc) = 0.05384204$$

$$v = Asl_{mid} / (b * d) * (fsv / fc) = 0.03286221$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < vs, y2$ - LHS eq.(4.5) is satisfied

--->

$$su (4.9) = 0.16841906$$

$$Mu = MRc (4.14) = 1.5380E+008$$

$$u = su (4.1) = 1.7246351E-005$$

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Mu_{2+}

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 1.7246351E-005$$

$$Mu = 1.5380E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$fc = 33.00$$

$$co (5A.5, TBDY) = 0.002$$

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00514506$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } cu = 0.00514506$$

$$we (5.4c) = 0.00169139$$

$$ase ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.25908

Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25223
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25908
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00

y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 0.30

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by 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 = 389.0139

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.30

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

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 $fs_2 = (fs_{jacket} \cdot A_{s1,com,jacket} + fs_{core} \cdot A_{s1,com,core}) / A_{s1,com} = 389.0139$

with $Es_2 = (Es_{jacket} \cdot A_{s1,com,jacket} + Es_{core} \cdot A_{s1,com,core}) / A_{s1,com} = 200000.00$

$y_v = 0.00140044$

$sh_v = 0.0044814$

$ft_v = 466.8167$

$fy_v = 389.0139$

$suv = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$l_o/l_{o,min} = l_b/l_d = 0.30$

$suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered

characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fsv = (fs_{jacket} \cdot A_{s,mid,jacket} + fs_{mid} \cdot A_{s,mid,core}) / A_{s,mid} = 389.0139$

with $Es_v = (Es_{jacket} \cdot A_{s,mid,jacket} + Es_{mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$

$1 = A_{s,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.04490101$

$2 = A_{s,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.04490101$

$v = A_{s,mid} / (b \cdot d) \cdot (fsv / fc) = 0.0274051$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

fcc (5A.2, TBDY) = 33.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

$1 = A_{s,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.05384204$

$2 = A_{s,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.05384204$

$v = A_{s,mid} / (b \cdot d) \cdot (fsv / fc) = 0.03286221$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.16841906

$Mu = MRc$ (4.14) = 1.5380E+008

$u = su$ (4.1) = 1.7246351E-005

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Mu_2 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 1.7246351E-005$

$Mu = 1.5380E+008$

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 : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.00514506$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $cu = 0.00514506$
 we (5.4c) = 0.00169139
 ase ((5.4d), TBDY) = $(ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$

$psh_{min} \cdot Fywe = \text{Min}(psh_x \cdot Fywe, psh_y \cdot Fywe) = 1.25908$

Expression ((5.4d), TBDY) for $psh_{min} \cdot Fywe$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $psh_x \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 2.25223$
 $ps1$ (external) = $(Ash1 \cdot h1 / s1) / A_{sec} = 0.00261799$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2$ (internal) = $(Ash2 \cdot h2 / s2) / A_{sec} = 0.00062519$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

 $psh_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.25908$
 $ps1$ (external) = $(Ash1 \cdot h1 / s1) / A_{sec} = 0.00156298$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2$ (internal) = $(Ash2 \cdot h2 / s2) / A_{sec} = 0.00025008$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

 $A_{sec} = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 694.45$
 $fywe2 = 694.45$
 $fce = 33.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$

$y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 466.8167$
 $fy1 = 389.0139$
 $su1 = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$lo/lou_{min} = lb/ld = 0.30$
 $su1 = 0.4 \cdot esu1_{nominal} \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu1_{nominal} = 0.08$,

For calculation of $esu1_{nominal}$ and $y1, sh1, ft1, fy1$, it is considered characteristic value $fsy1 = fs1 / 1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs_{jacket} \cdot A_{sl,ten,jacket} + fs_{core} \cdot A_{sl,ten,core}) / A_{sl,ten} = 389.0139$

with $Es1 = (Es_{jacket} \cdot A_{sl,ten,jacket} + Es_{core} \cdot A_{sl,ten,core}) / A_{sl,ten} = 200000.00$

$y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 466.8167$
 $fy2 = 389.0139$
 $su2 = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o/l_{o,min} = l_b/l_{b,min} = 0.30$$

$$s_u2 = 0.4 * e_{s_u2_nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{s_u2_nominal} = 0.08$,

For calculation of $e_{s_u2_nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered characteristic value $f_{s_y2} = f_{s_2}/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } f_{s_2} = (f_{s_jacket} * A_{s_com,jacket} + f_{s_core} * A_{s_com,core}) / A_{s_com} = 389.0139$$

$$\text{with } E_{s_2} = (E_{s_jacket} * A_{s_com,jacket} + E_{s_core} * A_{s_com,core}) / A_{s_com} = 200000.00$$

$$y_v = 0.00140044$$

$$sh_v = 0.0044814$$

$$ft_v = 466.8167$$

$$fy_v = 389.0139$$

$$s_{u_v} = 0.00512$$

using (30) in Bisikinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o/l_{o,min} = l_b/l_d = 0.30$$

$$s_{u_v} = 0.4 * e_{s_{u_v_nominal}} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{s_{u_v_nominal}} = 0.08$,

considering characteristic value $f_{s_{y_v}} = f_{s_v}/1.2$, from table 5.1, TBDY

For calculation of $e_{s_{u_v_nominal}}$ and y_v, sh_v, ft_v, fy_v , it is considered characteristic value $f_{s_{y_v}} = f_{s_v}/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } f_{s_v} = (f_{s_jacket} * A_{s_mid,jacket} + f_{s_mid} * A_{s_mid,core}) / A_{s_mid} = 389.0139$$

$$\text{with } E_{s_v} = (E_{s_jacket} * A_{s_mid,jacket} + E_{s_mid} * A_{s_mid,core}) / A_{s_mid} = 200000.00$$

$$1 = A_{s_ten} / (b * d) * (f_{s_1} / f_c) = 0.04490101$$

$$2 = A_{s_com} / (b * d) * (f_{s_2} / f_c) = 0.04490101$$

$$v = A_{s_mid} / (b * d) * (f_{s_v} / f_c) = 0.0274051$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 33.00$$

$$cc (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{s_ten} / (b * d) * (f_{s_1} / f_c) = 0.05384204$$

$$2 = A_{s_com} / (b * d) * (f_{s_2} / f_c) = 0.05384204$$

$$v = A_{s_mid} / (b * d) * (f_{s_v} / f_c) = 0.03286221$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

$v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied

---->

$$s_u (4.9) = 0.16841906$$

$$\mu_u = M_{Rc} (4.14) = 1.5380E+008$$

$$u = s_u (4.1) = 1.7246351E-005$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 383231.42$

Calculation of Shear Strength at edge 1, $V_{r1} = 383231.42$

$$V_{r1} = V_n ((22.5.1.1), ACI 318-14)$$

NOTE: In expression (22.5.1.1) 'V_w' is replaced by 'V_w + f * V_f'
where V_f is the contribution of FRPs (11.3), ACI 440).

$$\text{From Table (22.5.5.1), ACI 318-14: } V_c = 197061.477$$

$$= 1 \text{ (normal-weight concrete)}$$

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)

pw = $A_s/(b_w*d) = 0.00331157$
As (tension reinf.) = 709.9999
bw = 670.00
d = 320.00
 $V_u*d/\mu < 1 = 0.00$
 $\mu = 5.3381491E-011$
 $V_u = 3.1831679E-014$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 186169.943$

$V_{s1} = 186169.943$ is calculated for jacket, with:

d = 320.00
 $A_v = 157079.633$
fy = 555.56
s = 150.00

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 0.00$ is calculated for jacket, with:

d2 = 160.00
 $A_v = 100530.965$
fy = 555.56
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, $V_{r2} = 383231.42$

$V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_{w+ f*V_f}$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 197061.477$
= 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)

pw = $A_s/(b_w*d) = 0.00331157$
As (tension reinf.) = 709.9999
bw = 670.00
d = 320.00

$V_u*d/\mu < 1 = 0.00$
 $\mu = 4.2118567E-011$
 $V_u = 3.1831679E-014$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 186169.943$

$V_{s1} = 186169.943$ is calculated for jacket, with:

d = 320.00
 $A_v = 157079.633$
fy = 555.56
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 = 555.56
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: 3

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 0.85$

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$

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, $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_b/l_d = 0.30$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = -4.8656409E-011$

Shear Force, $V_2 = 6.6781494E-014$

Shear Force, $V_3 = 18821.457$

Axial Force, $F = -4363.163$

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: $A_{sl,mid} = 556.0619$

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten,jacket} = 603.1858$

-Compression: $A_{sl,com,jacket} = 603.1858$

-Middle: $A_{sl,mid,jacket} = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten,core} = 307.8761$

-Compression: $A_{sl,com,core} = 307.8761$

-Middle: $A_{sl,mid,core} = 153.938$

Mean Diameter of Tension Reinforcement, $Db_L = 15.20$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_{,R} = 1.0^*$ $u = 0.02193358$

$u = y + p = 0.02193358$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00193358$ ((4.29), Biskinis Phd))

$M_y = 1.1193E+008$

$L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 1500.00

From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 2.8943E+013$

Calculation of Yielding Moment M_y

Calculation of ρ_y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 5.6171754E-006$
with $((10.1), \text{ASCE 41-17}) f_y = \text{Min}(f_y, 1.25 \cdot f_y \cdot (l_b/d)^{2/3}) = 311.2112$
 $d = 357.00$
 $y = 0.22404068$
 $A = 0.01000128$
 $B = 0.00562873$
with $pt = 0.00380895$
 $pc = 0.00380895$
 $pv = 0.00232477$
 $N = 4363.163$
 $b = 670.00$
 $" = 0.12044818$
 $y_{comp} = 2.7617881E-005$
with $fc = 33.00$
 $E_c = 26999.444$
 $y = 0.22313775$
 $A = 0.00990121$
 $B = 0.00557012$
with $E_s = 200000.00$

Calculation of ratio l_b/d

Inadequate Lap Length with $l_b/d = 0.30$

- Calculation of ρ_p -

From table 10-7: $\rho_p = 0.02$

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 $V_p/V_o = 0.26755321$
- Transverse Reinforcement: NC
- Stirrup Spacing $> d/3$
- Low ductility demand, $\rho_y / \rho_p < 2$ (table 10-6, ASCE 41-17)
 $= -6.4267787E-022$
- Stirrup Spacing $\leq d/2$
 $d = d_{external} = 357.00$
 $s = s_{external} = 150.00$
- Strength provided by hoops $V_s < 3/4 \cdot \text{design Shear}$
 $V_s = 215957.134$, already given in calculation of shear control ratio
design Shear = $6.6781494E-014$
- $(\rho_p - \rho_y) / \rho_{bal} = -0.23508921$
 $= A_{st}/(b_w \cdot d) = 0.00296835$
Tension Reinf Area: $A_{st} = 709.9999$
 $\rho_y = A_{sc}/(b_w \cdot d) = 0.00697431$
Compression Reinf Area: $A_{sc} = 1668.186$
- From (B-1), ACI 318-11: $\rho_{bal} = 0.01704017$
 $fc = (fc_{jacket} \cdot Area_{jacket} + fc_{core} \cdot Area_{core}) / section_area = 33.00$
 $f_y = f_{y_jacket_bars} = 555.56$
From 10.2.7.3, ACI 318-11: $\beta_1 = 0.65$
From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + \rho_y) = 0.51922877$
 $\rho_y = 0.0027778$
- $V / (b_w \cdot d \cdot fc^{0.5}) = 5.8530115E-019$, NOTE: units in lb & in

bw = 670.00

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1
At local axis: 3
Integration Section: (b)
