

Detailed Member Calculations

Units: N&mm

Regulation: ASCE 41-17

Calculation No. 1

beam B1, Floor 1

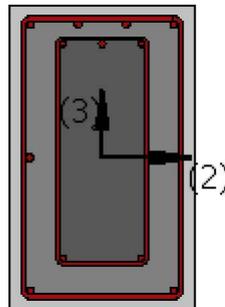
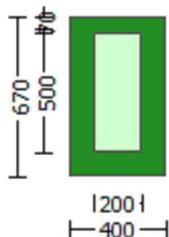
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: Start

Local Axis: (2)



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

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$

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

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

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

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

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

Stepwise Properties

EDGE -A-
Bending Moment, $M_a = 1.6825104E-011$
Shear Force, $V_a = 1.3365595E-014$
EDGE -B-
Bending Moment, $M_b = 2.3137405E-011$
Shear Force, $V_b = -1.3365595E-014$
BOTH EDGES
Axial Force, $F = -7187.067$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{s,t} = 709.9999$
-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, $D_{bL,ten} = 15.20$

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

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

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

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

Vs2 = 0.00 is calculated for core, with:

$d = 160.00$

$A_v = 100530.965$

$f_y = 420.00$

$s = 300.00$

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

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

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

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

At local axis: 2

Integration Section: (a)

Calculation No. 2

beam B1, Floor 1

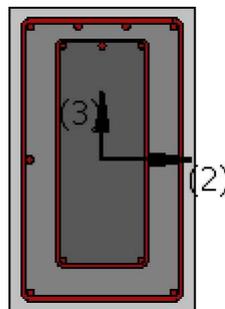
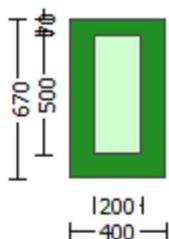
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (θ)

Edge: Start

Local Axis: (2)



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

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$

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

Consequently:

Jacket

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

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

Concrete Elasticity, $E_c = 25742.96$

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Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 24.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 525.00
Concrete Elasticity, Ec = 23025.204
Steel Elasticity, Es = 200000.00
#####
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 781.25
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 656.25
#####
External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lu,min>=1)
No FRP Wrapping
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Stepwise Properties
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At local axis: 3
EDGE -A-
Shear Force, Va = 9840.634
EDGE -B-
Shear Force, Vb = 9840.632
BOTH EDGES
Axial Force, F = -2309.833
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 709.9999
-Compression: Aslc = 1668.186
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 709.9999
-Compression: Asl,com = 1266.062
-Middle: Asl,mid = 402.1239
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Calculation of Shear Capacity ratio , Ve/Vr = 0.92480584
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 = 535287.788
with
Mpr1 = Max(Mu1+ , Mu1-) = 7.8817E+008
Mu1+ = 4.6479E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
Mu1- = 7.8817E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 7.8817E+008
Mu2+ = 4.6479E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
Mu2- = 7.8817E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination
and
± 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 κ_u according to 4.1, Biskinis/Fardis 2013:

$$\kappa_u = 5.6369735E-005$$

$$M_u = 4.6479E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

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

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

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

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

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

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

$$\kappa_{ase1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

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

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

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

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

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

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

$$h1 = 670.00$$

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

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

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

$$h2 = 500.00$$

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

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

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

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

$$h1 = 400.00$$

$$\kappa_{ps2} \text{ (internal)} = (A_{sh2} * h2 / s2) / A_{sec} = 0.00025008$$

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

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

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

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

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

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 872.4558$$

$$fy1 = 727.0465$$

$$su1 = 0.032$$

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

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

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

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.

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

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

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 882.7854$$

$$fy2 = 735.6545$$

$$su2 = 0.032$$

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

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

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

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

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

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

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

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

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 937.50$$

$$fyv = 781.25$$

$$suv = 0.032$$

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

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

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

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

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

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

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

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

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

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.06860752$$

$$2 = Asl,com/(b*d)*(fs2/fc) = 0.12378842$$

$$v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

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

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

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

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.08477074$$

$$2 = Asl,com/(b*d)*(fs2/fc) = 0.15295169$$

$$v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$su (4.9) = 0.09460844$$

$$Mu = MRc (4.14) = 4.6479E+008$$

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

Calculation of ratio l_b/l_d

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

Calculation of μ_1

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

$$u = 6.0907698E-005$$

$$\mu = 7.8817E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

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

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

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

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

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

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

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

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\text{psh}_{\min} * F_{ywe} = \text{Min}(\text{psh}_{x_1} * F_{ywe_1}, \text{psh}_{y_1} * F_{ywe_1}) = 1.38519$$

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

$$\text{psh}_{x_1} * F_{ywe_1} = \text{psh}_1 * F_{ywe_1} + \text{ps}_2 * F_{ywe_2} = 2.45559$$

$$\text{ps}_1(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

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

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

$$h_1 = 670.00$$

$$\text{ps}_2(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

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

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

$$h_2 = 500.00$$

$$\text{psh}_{y_1} * F_{ywe_1} = \text{psh}_1 * F_{ywe_1} + \text{ps}_2 * F_{ywe_2} = 1.38519$$

$$\text{ps}_1(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

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

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

$$h_1 = 400.00$$

$$\text{ps}_2(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe_1} = 781.25$$

$$f_{ywe_2} = 656.25$$

fce = 30.00

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

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 882.7854

fy1 = 735.6545

su1 = 0.032

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

lo/lou,min = lb/ld = 1.00

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

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 735.6545

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

y2 = 0.0025

sh2 = 0.008

ft2 = 872.4558

fy2 = 727.0465

su2 = 0.032

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

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

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

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

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

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

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 727.0465

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

yv = 0.0025

shv = 0.008

ftv = 937.50

fyv = 781.25

suv = 0.032

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

lo/lou,min = lb/ld = 1.00

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

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

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

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value 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 = 781.25

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.12378842

2 = Asl,com/(b*d)*(fs2/fc) = 0.06860752

v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 30.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.15295169

2 = Asl,com/(b*d)*(fs2/fc) = 0.08477074

v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->
v < vs,y2 - LHS eq.(4.5) is not satisfied

--->
v < vs,c - RHS eq.(4.5) is satisfied

--->
su (4.8) = 0.16206515
Mu = MRc (4.15) = 7.8817E+008
u = su (4.1) = 6.0907698E-005

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu2+

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

u = 5.6369735E-005
Mu = 4.6479E+008

with full section properties:

b = 400.00
d = 627.00
d' = 43.00
v = 0.000307
N = 2309.833
fc = 30.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0053097
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0053097

we (5.4c) = 0.00204688
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.38519

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

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

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

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 781.25

fywe2 = 656.25

fce = 30.00

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

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 872.4558

fy1 = 727.0465

su1 = 0.032

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

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

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

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

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

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

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

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

y2 = 0.0025

sh2 = 0.008

ft2 = 882.7854

fy2 = 735.6545

su2 = 0.032

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

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

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

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

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

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

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

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

yv = 0.0025

shv = 0.008

ftv = 937.50

fyv = 781.25

suv = 0.032

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

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

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

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

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

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

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 781.25

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.06860752

2 = Asl,com/(b*d)*(fs2/fc) = 0.12378842

v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 30.00

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

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

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.08477074$$

$$2 = Asl,com/(b*d)*(fs2/fc) = 0.15295169$$

$$v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117$$

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

--->

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

--->

$$su \text{ (4.9)} = 0.09460844$$

$$Mu = MRc \text{ (4.14)} = 4.6479E+008$$

$$u = su \text{ (4.1)} = 5.6369735E-005$$

Calculation of ratio l_b/l_d

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

Calculation of Mu_2 -

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

$$u = 6.0907698E-005$$

$$Mu = 7.8817E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$fc = 30.00$$

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

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

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

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

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

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

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

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

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

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

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

$$psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.45559$$

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

$$Ash1 = Astir_1*ns_1 = 157.0796$$

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

$$h1 = 670.00$$

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

$$Ash2 = Astir_2*ns_2 = 100.531$$

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

$$h2 = 500.00$$

$$psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.38519$$

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

$$Ash1 = Astir_1*ns_1 = 157.0796$$

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

 $Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 781.25$
 $fywe2 = 656.25$
 $fce = 30.00$

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

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

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

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

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

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

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

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

with $fs1 = (fs,jacket \cdot Asl,ten,jacket + fs,core \cdot Asl,ten,core) / Asl,ten = 735.6545$

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

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

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

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

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

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

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

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

with $fs2 = (fs,jacket \cdot Asl,com,jacket + fs,core \cdot Asl,com,core) / Asl,com = 727.0465$

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

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

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

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

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

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

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

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

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

with $fsv = (fs,jacket \cdot Asl,mid,jacket + fs,mid \cdot Asl,mid,core) / Asl,mid = 781.25$

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

$1 = Asl,ten / (b \cdot d) \cdot (fs1 / fce) = 0.12378842$
 $2 = Asl,com / (b \cdot d) \cdot (fs2 / fce) = 0.06860752$
 $v = Asl,mid / (b \cdot d) \cdot (fsv / fce) = 0.04175429$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

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

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

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

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.15295169$$

$$2 = Asl,com/(b*d)*(fs2/fc) = 0.08477074$$

$$v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

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

--->

$$su (4.8) = 0.16206515$$

$$Mu = MRc (4.15) = 7.8817E+008$$

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

Calculation of ratio l_b/d

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

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

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

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

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

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

= 1 (normal-weight concrete)

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

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

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

$$bw = 400.00$$

$$d = 536.00$$

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

$$Mu = 1.1510E+006$$

$$Vu = 9840.634$$

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

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

$$d = 536.00$$

$$A_v = 157079.633$$

$$f_y = 625.00$$

$$s = 150.00$$

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

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

$$d_2 = 400.00$$

$$A_v = 100530.965$$

$$f_y = 525.00$$

$$s = 300.00$$

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

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

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

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

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

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

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

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

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

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

Constant Properties

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

Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$
Existing Column
Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 656.25$

External Height, $H = 670.00$

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

Stepwise Properties

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

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

Calculation of μ_{u1+}

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

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

with full section properties:

$b = 670.00$
 $d = 357.00$

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

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

$psh_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.38519$
 $ps1 (external) = (Ash1 * h1 / s1) / Asec = 0.00156298$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 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, $ns_2 = 2.00$
 $h2 = 200.00$

$Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 781.25$
 $fywe2 = 656.25$
 $fce = 30.00$

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

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

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

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

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

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

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

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

with $fs1 = (fs, jacket * Asl, ten, jacket + fs, core * Asl, ten, core) / Asl, ten = 739.0086$

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

$y2 = 0.0025$

$$sh_2 = 0.008$$

$$ft_2 = 886.8103$$

$$fy_2 = 739.0086$$

$$su_2 = 0.032$$

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

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

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

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

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

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

with $fs_2 = (fs_{jacket} * Asl_{com,jacket} + fs_{core} * Asl_{com,core}) / Asl_{com} = 739.0086$

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

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 895.9746$$

$$fyv = 746.6455$$

$$suv = 0.032$$

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

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

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

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.

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

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

$$1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.09382814$$

$$2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.09382814$$

$$v = Asl_{mid} / (b * d) * (fsv / fc) = 0.05785932$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

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

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

c = confinement factor = 1.00

$$1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.11251192$$

$$2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.11251192$$

$$v = Asl_{mid} / (b * d) * (fsv / fc) = 0.06938071$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

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

--->

$$su (4.9) = 0.1468828$$

$$Mu = MRc (4.14) = 3.2725E+008$$

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

Calculation of ratio lb/ld

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

Calculation of Mu_1 -

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

$$u = 0.00010507$$

$$\mu = 3.2725E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

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

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

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

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

$$w_e(5.4c) = 0.00204688$$

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

$$a_{se1} = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i2,1} = 975400.00$$

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

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i2,2} = 557856.00$$

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

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

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

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

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

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 886.8103$$

$$fy_1 = 739.0086$$

$$su_1 = 0.032$$

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

$$l_o / l_{o, \min} = l_b / d = 1.00$$

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

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

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

characteristic value $f_{sy1} = f_{s1}/1.2$, from table 5.1, TBDY.

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

with $f_{s1} = (f_{s,jacket} \cdot A_{s,ten,jacket} + f_{s,core} \cdot A_{s,ten,core})/A_{s,ten} = 739.0086$

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

$y_2 = 0.0025$

$sh_2 = 0.008$

$ft_2 = 886.8103$

$fy_2 = 739.0086$

$su_2 = 0.032$

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$l_o/l_{o,min} = l_b/l_{b,min} = 1.00$

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

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

For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered

characteristic value $f_{sy2} = f_{s2}/1.2$, from table 5.1, TBDY.

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

with $f_{s2} = (f_{s,jacket} \cdot A_{s,com,jacket} + f_{s,core} \cdot A_{s,com,core})/A_{s,com} = 739.0086$

with $E_{s2} = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core})/A_{s,com} = 200000.00$

$y_v = 0.0025$

$sh_v = 0.008$

$ft_v = 895.9746$

$fy_v = 746.6455$

$su_v = 0.032$

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

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

$su_v = 0.4 \cdot esu_{v,nominal} ((5.5), TBDY) = 0.032$

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

considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY

For calculation of $esu_{v,nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered

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

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

with $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core})/A_{s,mid} = 746.6455$

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

$1 = A_{s,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.09382814$

$2 = A_{s,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.09382814$

$v = A_{s,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.05785932$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

$f_{cc} (5A.2, TBDY) = 30.00$

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

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

$1 = A_{s,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.11251192$

$2 = A_{s,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.11251192$

$v = A_{s,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.06938071$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

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

---->

$su (4.9) = 0.1468828$

$Mu = MRc (4.14) = 3.2725E+008$

$u = su (4.1) = 0.00010507$

Calculation of ratio l_b/l_d

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

Calculation of Mu_{2+}

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

$$u = 0.00010507$$

$$\mu = 3.2725E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

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

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

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

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

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

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

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

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

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

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

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

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

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 886.8103$$

$$fy_1 = 739.0086$$

$$su_1 = 0.032$$

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

Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

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

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 739.0086

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

y2 = 0.0025

sh2 = 0.008

ft2 = 886.8103

fy2 = 739.0086

su2 = 0.032

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

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

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

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

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

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

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086

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

yv = 0.0025

shv = 0.008

ftv = 895.9746

fyv = 746.6455

suv = 0.032

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

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

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

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

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

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

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814

2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814

v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 30.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192

2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192

v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

v < vs,c - RHS eq.(4.5) is satisfied

--->

su (4.9) = 0.1468828

Mu = MRc (4.14) = 3.2725E+008

u = su (4.1) = 0.00010507

Calculation of ratio lb/d

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

Calculation of μ_2 -

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

$$\mu = 0.00010507$$

$$\mu = 3.2725E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

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

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

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

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

$$w_e \text{ (5.4c)} = 0.00204688$$

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

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

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

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

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

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

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

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, $n_{s_2} = 2.00$

$$h_2 = 500.00$$

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

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

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

No stirrups, $n_{s_1} = 2.00$

$$h_1 = 400.00$$

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

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

No stirrups, $n_{s_2} = 2.00$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

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

c = confinement factor = 1.00

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

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

$$u = s_u(4.1) = 0.00010507$$

Calculation of ratio l_b/d

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

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

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

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

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

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

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

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

s = 150.00

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

Vs2 = 0.00 is calculated for jacket, with:

d = 160.00

Av = 100530.965

fy = 525.00

s = 300.00

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

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

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

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

At local axis: 2

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

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$

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

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

Consequently:

Jacket

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

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

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

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

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

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 5.6604E+006$

Shear Force, $V_2 = 1.3365595E-014$

Shear Force, $V_3 = 4044.385$

Axial Force, $F = -7187.067$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 709.9999$

-Compression: $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

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

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

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

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

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

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

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

Mean Diameter of Tension Reinforcement, $DbL = 15.00$

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

- Calculation of y -

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

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

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

Calculation of ratio lb/d

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

- Calculation of p -

From table 10-7: $p = 0.01$

with:

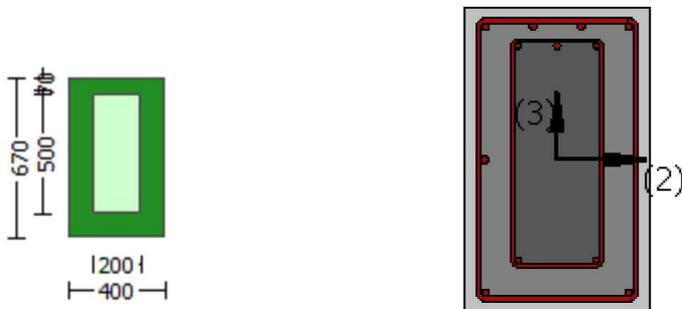
- Condition i occurred
- Beam controlled by flexure: $Vp/Vo \leq 1$
- shear control ratio $Vp/Vo = 0.92480584$
- Transverse Reinforcement: C
- Stirrup Spacing $\leq d/3$
- Low ductility demand, $\rho / y < 2$ (table 10-6, ASCE 41-17)
= $5.9864941E-005$

- Stirrup Spacing $\leq d/2$
 $d = d_{\text{external}} = 627.00$
 $s = s_{\text{external}} = 150.00$
- Strength provided by hoops $V_s < 3/4 \cdot \text{design Shear}$
 $V_s = 421182.855$, already given in calculation of shear control ratio
design Shear = 4044.385
- $(-) / \rho_{\text{bal}} = -0.3178459$
 $= A_{\text{st}} / (b_w \cdot d) = 0.00283094$
Tension Reinf Area: $A_{\text{st}} = 709.9999$
 $\rho' = A_{\text{sc}} / (b_w \cdot d) = 0.00665146$
Compression Reinf Area: $A_{\text{sc}} = 1668.186$
- From (B-1), ACI 318-11: $\rho_{\text{bal}} = 0.01202003$
 $f_c = (f_{c_{\text{jacket}}} \cdot \text{Area}_{\text{jacket}} + f_{c_{\text{core}}} \cdot \text{Area}_{\text{core}}) / \text{section_area} = 27.76119$
 $f_y = f_{y_{\text{jacket_bars}}} = 625.00$
From 10.2.7.3, ACI 318-11: $\beta_1 = 0.65$
From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + f_y) = c_b / d_t = 0.003 / (0.003 + \rho) = 0.48979592$
 $\rho = 0.003125$
- $V / (b_w \cdot d \cdot f_c^{0.5}) = 0.03685777$, NOTE: units in lb & in
 $b_w = 400.00$

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

Calculation No. 3

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



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

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$

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

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

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

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

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

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

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

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 5.6604E+006$

Shear Force, $V_a = 4044.385$

EDGE -B-

Bending Moment, $M_b = 1.1729E+007$

Shear Force, $V_b = 15636.882$

BOTH EDGES

Axial Force, $F = -7187.067$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 709.9999$

-Compression: $A_{sc} = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

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

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

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

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

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

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

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: $V_c = 152199.308$

= 1 (normal-weight concrete)

Mean concrete strength: $f_c' = (f_c'_{jacket} * Area_{jacket} + f_c'_{core} * Area_{core}) / Area_{section} = 18.50746$, but $f_c'^{0.5} <=$
8.3 MPa (22.5.3.1, ACI 318-14)

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

A_s (tension reinf.) = 709.9999

b_w = 400.00

d = 536.00

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

$M_u = 5.6604E+006$

$V_u = 4044.385$

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

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

$d = 536.00$

$A_v = 157079.633$

$f_y = 500.00$

$s = 150.00$

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

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

$d = 400.00$

$A_v = 100530.965$

$f_y = 420.00$

$s = 300.00$

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

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

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

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

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

At local axis: 3

Integration Section: (a)

Calculation No. 4

beam B1, Floor 1

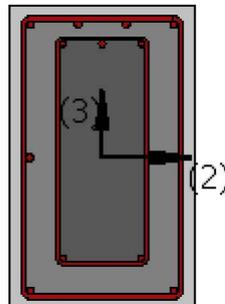
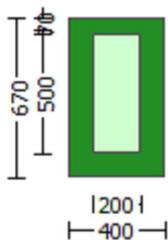
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (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, $\gamma = 0.87$

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

Consequently:

Jacket

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

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

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

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

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

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

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

Jacket

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

Existing Column

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

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 9840.634$

EDGE -B-

Shear Force, $V_b = 9840.632$

BOTH EDGES

Axial Force, $F = -2309.833$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 709.9999$

-Compression: $A_{sc} = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

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

-Compression: $A_{sc, \text{com}} = 1266.062$

-Middle: $A_{sc, \text{mid}} = 402.1239$

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

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

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

with

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

$Mu_{1+} = 4.6479E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

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

$Mpr2 = \text{Max}(Mu_{2+}, Mu_{2-}) = 7.8817E+008$

$Mu_{2+} = 4.6479E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

$Mu_{2-} = 7.8817E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

and

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

with

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

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

Calculation of Mu_{1+}

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

$u = 5.6369735E-005$

$Mu = 4.6479E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.000307$

$N = 2309.833$

$fc = 30.00$

co (5A.5, TBDY) = 0.002

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

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

From (5.4b), TBDY: $cu = 0.0053097$

w_e (5.4c) = 0.00204688

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

$ase1 = 0.14776895$

$bo_1 = 340.00$

$ho_1 = 610.00$

$bi2_1 = 975400.00$

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

$bo_2 = 192.00$

$ho_2 = 492.00$

$bi2_2 = 557856.00$

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

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)

 $psh_x*Fy_{we} = psh1*Fy_{we1} + ps2*Fy_{we2} = 2.45559$

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

$Ash1 = Astir_1*ns_1 = 157.0796$

No stirrups, $ns_1 = 2.00$

$h1 = 670.00$

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

$Ash2 = Astir_2*ns_2 = 100.531$

No stirrups, $ns_2 = 2.00$

$h2 = 500.00$

$psh_y*Fy_{we} = psh1*Fy_{we1} + ps2*Fy_{we2} = 1.38519$

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

$Ash1 = Astir_1*ns_1 = 157.0796$

No stirrups, $ns_1 = 2.00$

$h1 = 400.00$

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

$Ash2 = Astir_2*ns_2 = 100.531$

No stirrups, $ns_2 = 2.00$

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 781.25

fywe2 = 656.25

fce = 30.00

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

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 872.4558

fy1 = 727.0465

su1 = 0.032

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

lo/lou,min = lb/lb = 1.00

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

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

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

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

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

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

y2 = 0.0025

sh2 = 0.008

ft2 = 882.7854

fy2 = 735.6545

su2 = 0.032

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

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

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

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

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

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

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

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

yv = 0.0025

shv = 0.008

ftv = 937.50

fyv = 781.25

suv = 0.032

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

lo/lou,min = lb/lb = 1.00

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

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

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value 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 = 781.25

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.06860752

2 = Asl,com/(b*d)*(fs2/fc) = 0.12378842

v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 30.00

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

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

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.08477074$$

$$2 = Asl,com/(b*d)*(fs2/fc) = 0.15295169$$

$$v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117$$

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

--->

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

--->

$$su \text{ (4.9)} = 0.09460844$$

$$Mu = MRc \text{ (4.14)} = 4.6479E+008$$

$$u = su \text{ (4.1)} = 5.6369735E-005$$

Calculation of ratio l_b/l_d

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

Calculation of Mu_1 -

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

$$u = 6.0907698E-005$$

$$Mu = 7.8817E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$fc = 30.00$$

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

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

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

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

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

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

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

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

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

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

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

$$psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.45559$$

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

$$Ash1 = Astir_1*ns_1 = 157.0796$$

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

$$h1 = 670.00$$

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

$$Ash2 = Astir_2*ns_2 = 100.531$$

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

$$h2 = 500.00$$

$$psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.38519$$

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

$$Ash1 = Astir_1*ns_1 = 157.0796$$

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

 $Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 781.25$
 $fywe2 = 656.25$
 $fce = 30.00$

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

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

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

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

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

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

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

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

with $fs1 = (fs,jacket \cdot Asl,ten,jacket + fs,core \cdot Asl,ten,core) / Asl,ten = 735.6545$

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

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

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

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

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

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

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

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

with $fs2 = (fs,jacket \cdot Asl,com,jacket + fs,core \cdot Asl,com,core) / Asl,com = 727.0465$

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

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

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

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

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

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

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

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

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

with $fsv = (fs,jacket \cdot Asl,mid,jacket + fs,mid \cdot Asl,mid,core) / Asl,mid = 781.25$

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

$1 = Asl,ten / (b \cdot d) \cdot (fs1 / fce) = 0.12378842$
 $2 = Asl,com / (b \cdot d) \cdot (fs2 / fce) = 0.06860752$
 $v = Asl,mid / (b \cdot d) \cdot (fsv / fce) = 0.04175429$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

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

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

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

$$1 = A_{sl,ten}/(b*d)*(fs1/fc) = 0.15295169$$

$$2 = A_{sl,com}/(b*d)*(fs2/fc) = 0.08477074$$

$$v = A_{sl,mid}/(b*d)*(fsv/fc) = 0.05159117$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

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

--->

$$s_u (4.8) = 0.16206515$$

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

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

Calculation of ratio l_b/d

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

Calculation of M_{u2+}

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

$$u = 5.6369735E-005$$

$$M_u = 4.6479E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

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

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

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

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

$$w_e (5.4c) = 0.00204688$$

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

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

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

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

$$p_{sh_x}*F_{ywe} = p_{sh1}*F_{ywe1} + p_{sh2}*F_{ywe2} = 2.45559$$

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

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

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

$$h1 = 670.00$$

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

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

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

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 781.25

fywe2 = 656.25

fce = 30.00

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

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 872.4558

fy1 = 727.0465

su1 = 0.032

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

lo/lou,min = lb/lb = 1.00

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

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

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

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

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

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

y2 = 0.0025

sh2 = 0.008

ft2 = 882.7854

fy2 = 735.6545

su2 = 0.032

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

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

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

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

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

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

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

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

yv = 0.0025

shv = 0.008

ftv = 937.50

fyv = 781.25

suv = 0.032

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

lo/lou,min = lb/lb = 1.00

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

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

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

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

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

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

with $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core})/A_{s,mid} = 781.25$

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

$1 = A_{s,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.06860752$

$2 = A_{s,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.12378842$

$v = A_{s,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.04175429$

and confined core properties:

$b = 340.00$

$d = 597.00$

$d' = 13.00$

f_{cc} (5A.2, TBDY) = 30.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

$1 = A_{s,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.08477074$

$2 = A_{s,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.15295169$

$v = A_{s,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.05159117$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

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

---->

su (4.9) = 0.09460844

$Mu = MRc$ (4.14) = 4.6479E+008

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

Calculation of ratio l_b/l_d

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

Calculation of Mu_2 -

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

$u = 6.0907698E-005$

$Mu = 7.8817E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.000307$

$N = 2309.833$

$f_c = 30.00$

co (5A.5, TBDY) = 0.002

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

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

From (5.4b), TBDY: $cu = 0.0053097$

we (5.4c) = 0.00204688

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

$ase_1 = 0.14776895$

$bo_1 = 340.00$

$ho_1 = 610.00$

$bi_2_1 = 975400.00$

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

$bo_2 = 192.00$

$ho_2 = 492.00$

$bi_2_2 = 557856.00$

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

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

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

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 = 1.38519
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 = 781.25
fywe2 = 656.25
fce = 30.00

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

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

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

lo/lou,min = lb/lb = 1.00

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$l_0/l_{ou,min} = l_b/d = 1.00$$

$$s_{uv} = 0.4 * e_{suv_nominal} ((5.5), TBDY) = 0.032$$

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

considering characteristic value $f_{sv} = f_{sv}/1.2$, 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.

$$\gamma_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b/d)^{2/3}), \text{ from } 10.3.5, \text{ ASCE } 41-17.$$

$$\text{with } f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 781.25$$

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

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.12378842$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.06860752$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.04175429$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 30.00$$

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

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

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

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

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

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

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

---->

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

---->

$$s_u (4.8) = 0.16206515$$

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

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

Calculation of ratio l_b/d

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

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

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

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

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

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

$$\text{From Table } (22.5.5.1), \text{ACI } 318-14: V_c = 192813.976$$

$$= 1 \text{ (normal-weight concrete)}$$

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

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

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

$$b_w = 400.00$$

$$d = 536.00$$

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

$$M_u = 1.1510E+006$$

$$V_u = 9840.634$$

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

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

$$d = 536.00$$

$$A_v = 157079.633$$

$$f_y = 625.00$$

$$s = 150.00$$

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

Vs2 = 35185.838 is calculated for jacket, with:

d2 = 400.00

Av = 100530.965

fy = 525.00

s = 300.00

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

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

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

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

Calculation of Shear Strength at edge 2, Vr2 = 578810.994

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

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

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

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

= 1 (normal-weight concrete)

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

pw = As/(bw*d) = 0.00331157

As (tension reinf.) = 709.9999

bw = 400.00

d = 536.00

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

$\mu = 1.1510E+006$

$V_u = 9840.632$

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

Vs1 = 350811.18 is calculated for jacket, with:

d = 536.00

Av = 157079.633

fy = 625.00

s = 150.00

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

Vs2 = 35185.838 is calculated for jacket, with:

d = 400.00

Av = 100530.965

fy = 525.00

s = 300.00

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

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

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

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

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

At local axis: 3

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

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

Knowledge Factor, = 0.87

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

Consequently:

Jacket

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

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

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

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

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

Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$
Existing Column
Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 656.25$

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

Stepwise Properties

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

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

Calculation of Mu1+

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

$$\mu = 0.00010507$$

$$Mu = 3.2725E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

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

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

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

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

$$w_e \text{ (5.4c)} = 0.00204688$$

$$a_s \text{ ((5.4d), TBDY)} = (a_{s1} * A_{ext} + a_{s2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{s1} = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i21} = 975400.00$$

$$a_{s2} = \text{Max}(a_{s1}, a_{s2}) = 0.14776895$$

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i22} = 557856.00$$

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

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

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

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

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

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 886.8103$$

$$fy_1 = 739.0086$$

$$su_1 = 0.032$$

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

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

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

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

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

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

with $fs_1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 739.0086$

with $Es_1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$

$y_2 = 0.0025$

$sh_2 = 0.008$

$ft_2 = 886.8103$

$fy_2 = 739.0086$

$su_2 = 0.032$

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

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

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

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

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

y_2, sh_2, ft_2, fy_2 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 739.0086$

with $Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$

$y_v = 0.0025$

$sh_v = 0.008$

$ft_v = 895.9746$

$fy_v = 746.6455$

$suv = 0.032$

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

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

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

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

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

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

with $fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 746.6455$

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

$1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.09382814$

$2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.09382814$

$v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.05785932$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

$f_{cc} (5A.2, TBDY) = 30.00$

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

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

$1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.11251192$

$2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.11251192$

$v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.06938071$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

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

--->

$su (4.9) = 0.1468828$

$Mu = MRc (4.14) = 3.2725E+008$

$u = su (4.1) = 0.00010507$

Calculation of ratio l_b/d

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

Calculation of μ_1

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

$$u = 0.00010507$$

$$\mu = 3.2725E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

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

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

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

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

$$w_e \text{ (5.4c)} = 0.00204688$$

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

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

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

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

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

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

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

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

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

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

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

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

lo/lou,min = lb/ld = 1.00

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

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 739.0086

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

y2 = 0.0025
sh2 = 0.008
ft2 = 886.8103
fy2 = 739.0086
su2 = 0.032

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

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

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

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

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

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

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086

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

yv = 0.0025
shv = 0.008
ftv = 895.9746
fyv = 746.6455
suv = 0.032

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

lo/lou,min = lb/ld = 1.00

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

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

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

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

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

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814

2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814

v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 30.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192

2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192

v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

v < vs,c - RHS eq.(4.5) is satisfied

---->

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

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

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

u = 0.00010507
Mu = 3.2725E+008

with full section properties:

b = 670.00
d = 357.00
d' = 43.00
v = 0.0003219
N = 2309.833
fc = 30.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0053097

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

From (5.4b), TBDY: cu = 0.0053097

we (5.4c) = 0.00204688

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

ase1 = 0.14776895

bo_1 = 340.00

ho_1 = 610.00

bi2_1 = 975400.00

ase2 = Max(ase1,ase2) = 0.14776895

bo_2 = 192.00

ho_2 = 492.00

bi2_2 = 557856.00

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

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

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.45559

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

Ash1 = Astir_1*ns_1 = 157.0796

No stirrups, ns_1 = 2.00

h1 = 670.00

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

Ash2 = Astir_2*ns_2 = 100.531

No stirrups, ns_2 = 2.00

h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.38519

ps1 (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

$$fy_{we1} = 781.25$$

$$fy_{we2} = 656.25$$

$$f_{ce} = 30.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 886.8103$$

$$fy_1 = 739.0086$$

$$su_1 = 0.032$$

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

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

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

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

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

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

$$\text{with } fs_1 = (fs_{\text{jacket}} * Asl, \text{ten, jacket} + fs_{\text{core}} * Asl, \text{ten, core}) / Asl, \text{ten} = 739.0086$$

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

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 886.8103$$

$$fy_2 = 739.0086$$

$$su_2 = 0.032$$

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

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

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

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

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

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

$$\text{with } fs_2 = (fs_{\text{jacket}} * Asl, \text{com, jacket} + fs_{\text{core}} * Asl, \text{com, core}) / Asl, \text{com} = 739.0086$$

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

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 895.9746$$

$$fy_v = 746.6455$$

$$suv = 0.032$$

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

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

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

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

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

For calculation of $esuv_{\text{nominal}}$ and y_v, sh_v, ft_v, fy_v , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

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

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

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

$$1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.09382814$$

$$2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.09382814$$

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

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

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

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

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

$$1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.11251192$$

$$2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.11251192$$

$$v = Asl, \text{mid} / (b * d) * (fsv / f_c) = 0.06938071$$

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

--->

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

--->

s_u (4.9) = 0.1468828

μ_u = MRc (4.14) = 3.2725E+008

u = s_u (4.1) = 0.00010507

Calculation of ratio l_b/d

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

Calculation of μ_{u2} -

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

u = 0.00010507

μ_u = 3.2725E+008

with full section properties:

b = 670.00

d = 357.00

d' = 43.00

v = 0.0003219

N = 2309.833

f_c = 30.00

α (5A.5, TBDY) = 0.002

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

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

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

w_e (5.4c) = 0.00204688

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

a_{se1} = 0.14776895

$b_{o,1}$ = 340.00

$h_{o,1}$ = 610.00

$b_{i2,1}$ = 975400.00

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

$b_{o,2}$ = 192.00

$h_{o,2}$ = 492.00

$b_{i2,2}$ = 557856.00

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

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

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

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, $n_{s,2} = 2.00$

$h_2 = 500.00$

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

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, $n_{s,2} = 2.00$

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 781.25

fywe2 = 656.25

fce = 30.00

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

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 886.8103

fy1 = 739.0086

su1 = 0.032

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

lo/lou,min = lb/lb = 1.00

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

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 739.0086

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

y2 = 0.0025

sh2 = 0.008

ft2 = 886.8103

fy2 = 739.0086

su2 = 0.032

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

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

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

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

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

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

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086

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

yv = 0.0025

shv = 0.008

ftv = 895.9746

fyv = 746.6455

suv = 0.032

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

lo/lou,min = lb/lb = 1.00

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

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

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

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814

2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814

v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 30.00

$$cc (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192$$

$$2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192$$

$$v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071$$

Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

$$su (4.9) = 0.1468828$$

$$Mu = MRc (4.14) = 3.2725E+008$$

$$u = su (4.1) = 0.00010507$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 390183.487$

Calculation of Shear Strength at edge 1, $V_{r1} = 390183.487$

$V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f_v V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_{c,jacket} \cdot \text{Area}_{jacket} + f'_{c,core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 27.76119$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$$pw = As/(bw*d) = 0.00331157$$

$$As (\text{tension reinf.}) = 709.9999$$

$$bw = 670.00$$

$$d = 320.00$$

$$V_u \cdot d / Mu < 1 = 0.00$$

$$Mu = 6.8565666E-012$$

$$V_u = 9.0372119E-015$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$

$V_{s1} = 209439.51$ is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 625.00$$

$$s = 150.00$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 0.00$ is calculated for jacket, with:

$$d_2 = 160.00$$

$$A_v = 100530.965$$

$$f_y = 525.00$$

$$s = 300.00$$

V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

V_f ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

Calculation of Shear Strength at edge 2, $V_{r2} = 390183.487$

$V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f_v V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_{c,jacket} \cdot \text{Area}_{jacket} + f'_{c,core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 27.76119$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$pw = A_s/(bw*d) = 0.00331157$

A_s (tension reinf.) = 709.9999

$bw = 670.00$

$d = 320.00$

$V_u*d/\mu < 1 = 0.00$

$\mu = 2.0256286E-011$

$V_u = 9.0372119E-015$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$

$V_{s1} = 209439.51$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 625.00$

$s = 150.00$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 0.00$ is calculated for jacket, with:

$d = 160.00$

$A_v = 100530.965$

$f_y = 525.00$

$s = 300.00$

V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

V_f ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 0.87$

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_b/l_d > 1$)

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 1.6825104E-011$
 Shear Force, $V2 = 1.3365595E-014$
 Shear Force, $V3 = 4044.385$
 Axial Force, $F = -7187.067$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 709.9999$
 -Compression: $As_c = 1668.186$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{,ten} = 911.0619$
 -Compression: $As_{,com} = 911.0619$
 -Middle: $As_{,mid} = 556.0619$
 Longitudinal External Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{,ten,jacket} = 603.1858$
 -Compression: $As_{,com,jacket} = 603.1858$
 -Middle: $As_{,mid,jacket} = 402.1239$
 Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{,ten,core} = 307.8761$
 -Compression: $As_{,com,core} = 307.8761$
 -Middle: $As_{,mid,core} = 153.938$
 Mean Diameter of Tension Reinforcement, $Db_L = 15.20$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = \phi u = 0.00791936$
 $u = y + p = 0.00910271$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00410271$ ((4.29), Biskinis Phd)
 $M_y = 2.1250E+008$
 $L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 1500.00
 From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 2.5898E+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 1.0750434E-005$
 with $f_y = 625.00$
 $d = 357.00$
 $y = 0.22791811$
 $A = 0.00999336$
 $B = 0.00562082$
 with $p_t = 0.00380895$
 $p_c = 0.00380895$
 $p_v = 0.00232477$
 $N = 7187.067$
 $b = 670.00$
 $\rho = 0.12044818$
 $y_{comp} = 2.5846388E-005$
 with $f_c = 27.76119$
 $E_c = 25742.96$
 $y = 0.22733547$
 $A = 0.00987104$
 $B = 0.00557012$
 with $E_s = 200000.00$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

- Calculation of p -

From table 10-7: $p = 0.005$

with:

- Condition i occurred

Beam controlled by flexure: $V_p/V_o \leq 1$

shear control ratio $V_p/V_o = 0.55914272$

- Transverse Reinforcement: NC

- Stirrup Spacing $> d/3$

- Low ductility demand, $\lambda < 2$ (table 10-6, ASCE 41-17)

$$= -3.6025504E-022$$

- Stirrup Spacing $\leq d/2$

$$d = d_{\text{external}} = 357.00$$

$$s = s_{\text{external}} = 150.00$$

- Strength provided by hoops $V_s < 3/4 \cdot \text{design Shear}$

$V_s = 237588.18$, already given in calculation of shear control ratio

design Shear = $1.3365595E-014$

- $(\lambda - 1)/\lambda = -0.33327376$

$$= A_s t / (b_w \cdot d) = 0.00296835$$

Tension Reinf Area: $A_s t = 709.9999$

$$= A_s c / (b_w \cdot d) = 0.00697431$$

Compression Reinf Area: $A_s c = 1668.186$

From (B-1), ACI 318-11: $\lambda = 0.01202003$

$$f_c = (f_{c_jacket} \cdot \text{Area}_{\text{jacket}} + f_{c_core} \cdot \text{Area}_{\text{core}}) / \text{section_area} = 27.76119$$

$$f_y = f_{y_jacket_bars} = 625.00$$

From 10.2.7.3, ACI 318-11: $\lambda = 0.65$

$$\text{From fig R10.3.3, ACI 318-11 (Ence 454, too): } 87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + \lambda) = 0.48979592$$

$$\lambda = 0.003125$$

- $V / (b_w \cdot d \cdot f_c^{0.5}) = 1.2771721E-019$, NOTE: units in lb & in

$$b_w = 670.00$$

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 5

beam B1, Floor 1

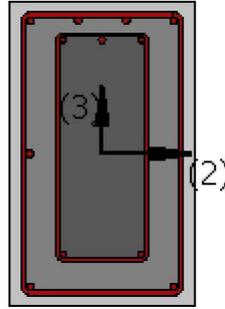
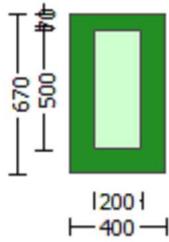
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 420.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{o,min} = l_b/l_d \geq 1$)

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 1.6825104E-011$

Shear Force, $V_a = 1.3365595E-014$

EDGE -B-

Bending Moment, $M_b = 2.3137405E-011$

Shear Force, $V_b = -1.3365595E-014$

BOTH EDGES

Axial Force, $F = -7187.067$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{sl} = 709.9999$

-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: $Asl_{mid} = 556.0619$

Mean Diameter of Tension Reinforcement, $DbL_{ten} = 15.20$

Existing component: From table 7-7, ASCE 41-17: Final Shear Capacity $VR = *Vn = 274161.749$
 $Vn ((22.5.1.1), ACI 318-14) = 315128.448$

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: $Vc = 147576.839$
= 1 (normal-weight concrete)

Mean concrete strength: $fc' = (fc'_{jacket} * Area_{jacket} + fc'_{core} * Area_{core}) / Area_{section} = 18.50746$, but $fc'^{0.5} < = 8.3$ MPa (22.5.3.1, ACI 318-14)

$pw = As / (bw * d) = 0.00331157$

As (tension reinf.) = 709.9999

bw = 670.00

d = 320.00

$Vu * d / Mu < 1 = 0.00$

$Mu = 2.3137405E-011$

$Vu = 1.3365595E-014$

From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 167551.608$

$Vs1 = 167551.608$ is calculated for jacket, with:

d = 320.00

$Av = 157079.633$

$fy = 500.00$

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

$Av = 100530.965$

$fy = 420.00$

s = 300.00

$Vs2$ is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

$Vf ((11-3)-(11.4), ACI 440) = 0.00$

From (11-11), ACI 440: $Vs + Vf < = 612724.122$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Calculation No. 6

beam B1, Floor 1

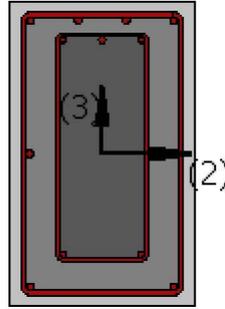
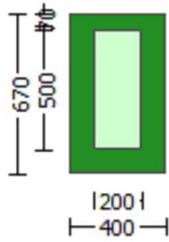
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (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, $\phi = 0.87$
 Mean strength values are used for both shear and moment calculations.
 Consequently:
 Jacket
 New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$
 New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$
 Concrete Elasticity, $E_c = 25742.96$
 Steel Elasticity, $E_s = 200000.00$
 Existing Column
 Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$
 Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$
 Concrete Elasticity, $E_c = 23025.204$
 Steel Elasticity, $E_s = 200000.00$
 #####
 Note: Especially for the calculation of moment strengths,
 the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
 Jacket
 New material: Steel Strength, $f_s = 1.25 * f_{sm} = 781.25$
 Existing Column
 Existing material: Steel Strength, $f_s = 1.25 * f_{sm} = 656.25$
 #####
 External Height, $H = 670.00$
 External Width, $W = 400.00$
 Internal Height, $H = 500.00$
 Internal Width, $W = 200.00$
 Cover Thickness, $c = 25.00$
 Mean Confinement Factor overall section = 1.00
 Element Length, $L = 3000.00$
 Secondary Member
 Smooth Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Adequate Lap Length ($l_o/l_{ou, min} >= 1$)
 No FRP Wrapping

Stepwise Properties

 At local axis: 3
 EDGE -A-
 Shear Force, $V_a = 9840.634$
 EDGE -B-
 Shear Force, $V_b = 9840.632$
 BOTH EDGES

Axial Force, $F = -2309.833$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_t = 709.9999$
-Compression: $As_c = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{t,ten} = 709.9999$
-Compression: $As_{c,com} = 1266.062$
-Middle: $As_{c,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.92480584$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 535287.788$
with

$M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 7.8817E+008$
 $Mu_{1+} = 4.6479E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
 $Mu_{1-} = 7.8817E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 7.8817E+008$
 $Mu_{2+} = 4.6479E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination
 $Mu_{2-} = 7.8817E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = 9840.634$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 9840.632$, is the shear force acting at edge 2 for the static loading combination

Calculation of Mu_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 5.6369735E-005$
 $M_u = 4.6479E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.000307$
 $N = 2309.833$
 $f_c = 30.00$
 α_1 (5A.5, TBDY) = 0.002
Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.0053097$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\phi_u = 0.0053097$
 w_e (5.4c) = 0.00204688
 α_{se} ((5.4d), TBDY) = $(\alpha_{se1} \cdot A_{ext} + \alpha_{se2} \cdot A_{int})/A_{sec} = 0.14776895$
 $\alpha_{se1} = 0.14776895$
 $b_{o,1} = 340.00$
 $h_{o,1} = 610.00$
 $b_{i,1} = 975400.00$
 $\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.14776895$
 $b_{o,2} = 192.00$
 $h_{o,2} = 492.00$
 $b_{i,2} = 557856.00$
 $\psi_{sh,min} \cdot F_{ywe} = \text{Min}(\psi_{sh,x} \cdot F_{ywe}, \psi_{sh,y} \cdot F_{ywe}) = 1.38519$
Expression ((5.4d), TBDY) for $\psi_{sh,min} \cdot F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $\psi_{sh,x} \cdot F_{ywe} = \psi_{sh1} \cdot F_{ywe1} + \psi_{sh2} \cdot F_{ywe2} = 2.45559$

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 = 1.38519
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 = 781.25
fywe2 = 656.25
fce = 30.00

From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00

y1 = 0.0025
sh1 = 0.008
ft1 = 872.4558
fy1 = 727.0465
su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

su1 = $0.4 \cdot esu1_nominal$ ((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 = $(fs_jacket \cdot Asl,ten,jacket + fs_core \cdot Asl,ten,core) / Asl,ten = 727.0465$

with Es1 = $(Es_jacket \cdot Asl,ten,jacket + Es_core \cdot Asl,ten,core) / Asl,ten = 200000.00$

y2 = 0.0025
sh2 = 0.008
ft2 = 882.7854
fy2 = 735.6545
su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = $0.4 \cdot esu2_nominal$ ((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 = $(fs_jacket \cdot Asl,com,jacket + fs_core \cdot Asl,com,core) / Asl,com = 735.6545$

with Es2 = $(Es_jacket \cdot Asl,com,jacket + Es_core \cdot Asl,com,core) / Asl,com = 200000.00$

yv = 0.0025
shv = 0.008
ftv = 937.50
fyv = 781.25
suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_0/l_{ou,min} = l_b/l_d = 1.00$$

$$s_{uv} = 0.4 * e_{suv_nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{suv_nominal} = 0.08$,

considering characteristic value $f_{sv} = f_{sv}/1.2$, 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.

$$\gamma_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b/l_d)^{2/3}), \text{ from } 10.3.5, \text{ ASCE } 41-17.$$

$$\text{with } f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 781.25$$

$$\text{with } E_{sv} = (E_{s,jacket} * A_{s,mid,jacket} + E_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 200000.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.06860752$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.12378842$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.04175429$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 30.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.08477074$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.15295169$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.05159117$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

---->

$$s_u (4.9) = 0.09460844$$

$$M_u = M_{Rc} (4.14) = 4.6479E+008$$

$$u = s_u (4.1) = 5.6369735E-005$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of M_{u1} -

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 6.0907698E-005$$

$$M_u = 7.8817E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\phi_{cu} = 0.0053097$

$$\text{we (5.4c)} = 0.00204688$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$psh_{min} * Fy_{we} = \text{Min}(psh_x * Fy_{we}, psh_y * Fy_{we}) = 1.38519$$

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)

$$psh_x * Fy_{we} = psh_1 * Fy_{we1} + ps_2 * Fy_{we2} = 2.45559$$
$$ps_1 \text{ (external)} = (Ash_1 * h_1 / s_1) / A_{sec} = 0.00261799$$
$$Ash_1 = Astir_1 * ns_1 = 157.0796$$
$$\text{No stirrups, } ns_1 = 2.00$$
$$h_1 = 670.00$$
$$ps_2 \text{ (internal)} = (Ash_2 * h_2 / s_2) / A_{sec} = 0.00062519$$
$$Ash_2 = Astir_2 * ns_2 = 100.531$$
$$\text{No stirrups, } ns_2 = 2.00$$
$$h_2 = 500.00$$

$$psh_y * Fy_{we} = psh_1 * Fy_{we1} + ps_2 * Fy_{we2} = 1.38519$$
$$ps_1 \text{ (external)} = (Ash_1 * h_1 / s_1) / A_{sec} = 0.00156298$$
$$Ash_1 = Astir_1 * ns_1 = 157.0796$$
$$\text{No stirrups, } ns_1 = 2.00$$
$$h_1 = 400.00$$
$$ps_2 \text{ (internal)} = (Ash_2 * h_2 / s_2) / A_{sec} = 0.00025008$$
$$Ash_2 = Astir_2 * ns_2 = 100.531$$
$$\text{No stirrups, } ns_2 = 2.00$$
$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$fy_{we1} = 781.25$$

$$fy_{we2} = 656.25$$

$$f_{ce} = 30.00$$

From ((5.A5), TBDY), TBDY: $cc = 0.002$

$c = \text{confinement factor} = 1.00$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 882.7854$$

$$fy_1 = 735.6545$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$lo/lou_{min} = lb/l_d = 1.00$$

$$su_1 = 0.4 * esu_{1_nominal} \text{ ((5.5), TBDY)} = 0.032$$

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.

$$\text{with } fs_1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 735.6545$$

$$\text{with } Es_1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$$

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 872.4558$$

$$fy_2 = 727.0465$$

$$su_2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$lo/lou_{min} = lb/l_{b,min} = 1.00$$

$$su_2 = 0.4 * esu_{2_nominal} \text{ ((5.5), TBDY)} = 0.032$$

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.

$$\text{with } fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 727.0465$$

$$\text{with } Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 937.50$$

$$f_{yv} = 781.25$$

$$s_{uv} = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_o/l_{ou,min} = l_b/l_d = 1.00$$

$$s_{uv} = 0.4 * e_{suv,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{suv,nominal} = 0.08$,

considering characteristic value $f_{sv} = f_{sv}/1.2$, 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.

$$\text{with } f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 781.25$$

$$\text{with } E_{sv} = (E_{s,jacket} * A_{s,mid,jacket} + E_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 200000.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.12378842$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.06860752$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.04175429$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 30.00$$

$$c_c (5A.5, TBDY) = 0.002$$

c = confinement factor = 1.00

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.15295169$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.08477074$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.05159117$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

$v < v_{s,y2}$ - LHS eq.(4.5) is not satisfied

---->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

---->

$$s_u (4.8) = 0.16206515$$

$$M_u = M_{Rc} (4.15) = 7.8817E+008$$

$$u = s_u (4.1) = 6.0907698E-005$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of M_{u2+}

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 5.6369735E-005$$

$$M_u = 4.6479E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_o (5A.5, TBDY) = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.0053097$$

$$w_e (5.4c) = 0.00204688$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.38519

Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.45559
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.38519
ps1 (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 = 781.25

fywe2 = 656.25

fce = 30.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 872.4558

fy1 = 727.0465

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 727.0465

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025

sh2 = 0.008

ft2 = 882.7854

fy2 = 735.6545

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered

characteristic value $f_{sy2} = f_{s2}/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $f_{s2} = (f_{sjacket} \cdot A_{s,com,jacket} + f_{s,core} \cdot A_{s,com,core})/A_{s,com} = 735.6545$

with $E_{s2} = (E_{sjacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core})/A_{s,com} = 200000.00$

$y_v = 0.0025$

$sh_v = 0.008$

$ft_v = 937.50$

$fy_v = 781.25$

$suv = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$l_o/l_{o,min} = l_b/l_d = 1.00$

$suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,

considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY

For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered

characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $f_{sv} = (f_{sjacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core})/A_{s,mid} = 781.25$

with $E_{sv} = (E_{sjacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core})/A_{s,mid} = 200000.00$

$1 = A_{s,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.06860752$

$2 = A_{s,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.12378842$

$v = A_{s,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.04175429$

and confined core properties:

$b = 340.00$

$d = 597.00$

$d' = 13.00$

$f_{cc} (5A.2, TBDY) = 30.00$

$cc (5A.5, TBDY) = 0.002$

$c = \text{confinement factor} = 1.00$

$1 = A_{s,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.08477074$

$2 = A_{s,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.15295169$

$v = A_{s,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.05159117$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$\mu_u (4.9) = 0.09460844$

$\mu_u = M/R_c (4.14) = 4.6479E+008$

$u = \mu_u (4.1) = 5.6369735E-005$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of μ_u

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:

$u = 6.0907698E-005$

$\mu_u = 7.8817E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.000307$

$N = 2309.833$

$f_c = 30.00$

$cc (5A.5, TBDY) = 0.002$

Final value of μ_u : $\mu_u^* = \text{shear_factor} \cdot \text{Max}(c_u, cc) = 0.0053097$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $c_u = 0.0053097$

w_e (5.4c) = 0.00204688

a_{se} ((5.4d), TBDY) = $(a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o,1} = 340.00$

$h_{o,1} = 610.00$

$b_{i2,1} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o,2} = 192.00$

$h_{o,2} = 492.00$

$b_{i2,2} = 557856.00$

$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.38519$

Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.45559$

p_{s1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir,1} * n_{s,1} = 157.0796$

No stirrups, $n_{s,1} = 2.00$

$h_1 = 670.00$

p_{s2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$

$A_{sh2} = A_{stir,2} * n_{s,2} = 100.531$

No stirrups, $n_{s,2} = 2.00$

$h_2 = 500.00$

 $p_{sh,y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.38519$

p_{s1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$

$A_{sh1} = A_{stir,1} * n_{s,1} = 157.0796$

No stirrups, $n_{s,1} = 2.00$

$h_1 = 400.00$

p_{s2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$

$A_{sh2} = A_{stir,2} * n_{s,2} = 100.531$

No stirrups, $n_{s,2} = 2.00$

$h_2 = 200.00$

 $A_{sec} = 268000.00$

$s_1 = 150.00$

$s_2 = 300.00$

$f_{ywe1} = 781.25$

$f_{ywe2} = 656.25$

$f_{ce} = 30.00$

From ((5.A5), TBDY), TBDY: $c_c = 0.002$

c = confinement factor = 1.00

$y_1 = 0.0025$

$sh_1 = 0.008$

$ft_1 = 882.7854$

$fy_1 = 735.6545$

$su_1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$l_o / l_{ou, \min} = l_b / l_d = 1.00$

$su_1 = 0.4 * esu_{1, \text{nominal}}$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esu_{1, \text{nominal}} = 0.08$,

For calculation of $esu_{1, \text{nominal}}$ and y_1, sh_1, ft_1, fy_1 , it is considered characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 735.6545$

with $Es_1 = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$

$y_2 = 0.0025$

$sh_2 = 0.008$

$ft_2 = 872.4558$

$fy_2 = 727.0465$

$su_2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 727.0465

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 937.50

fyv = 781.25

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

lo/lou,min = lb/ld = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered characteristic value 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 = 781.25

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.12378842

2 = Asl,com/(b*d)*(fs2/fc) = 0.06860752

v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 30.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.15295169

2 = Asl,com/(b*d)*(fs2/fc) = 0.08477074

v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

v < vs,y2 - LHS eq.(4.5) is not satisfied

--->

v < vs,c - RHS eq.(4.5) is satisfied

--->

su (4.8) = 0.16206515

Mu = MRc (4.15) = 7.8817E+008

u = su (4.1) = 6.0907698E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 578810.994

Calculation of Shear Strength at edge 1, Vr1 = 578810.994

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 = 192813.976

= 1 (normal-weight concrete)
Mean concrete strength: $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 27.76119$, but $fc'^{0.5} < = 8.3$ MPa (22.5.3.1, ACI 318-14)
 $pw = As / (bw \cdot d) = 0.00331157$
As (tension reinf.) = 709.9999
bw = 400.00
d = 536.00
 $Vu \cdot d / Mu < 1 = 1.00$
Mu = 1.1510E+006
Vu = 9840.634
From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 385997.017$
Vs1 = 350811.18 is calculated for jacket, with:
d = 536.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
Vs2 = 35185.838 is calculated for jacket, with:
d2 = 400.00
Av = 100530.965
fy = 525.00
s = 300.00
Vs2 has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $Vs + Vf < = 750430.726$

Calculation of Shear Strength at edge 2, Vr2 = 578810.994
Vr2 = Vn ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf' where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: Vc = 192813.976
= 1 (normal-weight concrete)
Mean concrete strength: $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 27.76119$, but $fc'^{0.5} < = 8.3$ MPa (22.5.3.1, ACI 318-14)
 $pw = As / (bw \cdot d) = 0.00331157$
As (tension reinf.) = 709.9999
bw = 400.00
d = 536.00
 $Vu \cdot d / Mu < 1 = 1.00$
Mu = 1.1510E+006
Vu = 9840.632
From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 385997.017$
Vs1 = 350811.18 is calculated for jacket, with:
d = 536.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
Vs2 = 35185.838 is calculated for jacket, with:
d = 400.00
Av = 100530.965
fy = 525.00
s = 300.00
Vs2 has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $Vs + Vf < = 750430.726$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 0.87$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, $f_s = 1.25 * f_{sm} = 781.25$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 * f_{sm} = 656.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou,min} > 1$)

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = -9.0372119E-015$

EDGE -B-

Shear Force, $V_b = 9.0372119E-015$

BOTH EDGES

Axial Force, $F = -2309.833$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 709.9999$

-Compression: $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{l,ten} = 911.0619$

-Compression: $As_{l,com} = 911.0619$

-Middle: $As_{l,mid} = 556.0619$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.55914272$

Member Controlled by Flexure ($V_e/V_r < 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u * l_n / 2 = 218168.257$

with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 3.2725E+008$
 $\mu_{u1+} = 3.2725E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{u1-} = 3.2725E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 3.2725E+008$
 $\mu_{u2+} = 3.2725E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
 $\mu_{u2-} = 3.2725E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination
and
 $\pm v_w \cdot l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = -9.0372119E-015$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 9.0372119E-015$, is the shear force acting at edge 2 for the the static loading combination

Calculation of μ_{u1+}

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:
 $u = 0.00010507$
 $\mu_u = 3.2725E+008$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.0003219$
 $N = 2309.833$
 $f_c = 30.00$
 $\alpha (5A.5, \text{TBDY}) = 0.002$
Final value of μ_{cu} : $\mu_{cu}^* = \text{shear_factor} * \text{Max}(\mu_{cu}, \mu_{cc}) = 0.0053097$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\mu_{cu} = 0.0053097$
 $w_e (5.4c) = 0.00204688$
 $a_{se} ((5.4d), \text{TBDY}) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$
 $p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.38519$
Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.45559$
 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, $n_{s_2} = 2.00$
 $h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.38519$
 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) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$

Ash2 = Astir₂*ns₂ = 100.531
No stirups, ns₂ = 2.00
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 781.25

fywe2 = 656.25

fce = 30.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 886.8103

fy1 = 739.0086

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^{2/3}), from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 739.0086

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025

sh2 = 0.008

ft2 = 886.8103

fy2 = 739.0086

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^{2/3}), from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 895.9746

fyv = 746.6455

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^{2/3}), from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814

2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814

v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932

and confined core properties:

b = 610.00

d = 327.00

$d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.11251192$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.11251192$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.06938071$
 Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)

--->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied

--->
 $su (4.9) = 0.1468828$
 $Mu = MRc (4.14) = 3.2725E+008$
 $u = su (4.1) = 0.00010507$

 Calculation of ratio l_b/d

 Adequate Lap Length: $l_b/d \geq 1$

 Calculation of Mu_1 -

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 0.00010507$
 $Mu = 3.2725E+008$

 with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.0003219$
 $N = 2309.833$
 $f_c = 30.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0053097$
 $w_e (5.4c) = 0.00204688$
 $ase ((5.4d), TBDY) = (ase1*A_{ext} + ase2*A_{int})/A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$
 $psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.38519$
 Expression ((5.4d), TBDY) for $psh_{min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.45559$
 $ps1$ (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, $ns_2 = 2.00$
 $h2 = 500.00$

 $psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.38519$

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$$

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$$

$$Ash2 = Astir_2 \cdot ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 781.25$$

$$fywe2 = 656.25$$

$$fce = 30.00$$

From ((5.A5), TBDY), TBDY: $cc = 0.002$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 886.8103$$

$$fy1 = 739.0086$$

$$su1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \text{min} = lb/d = 1.00$$

$$su1 = 0.4 \cdot esu1_{\text{nominal}} ((5.5), \text{TBDY}) = 0.032$$

From table 5A.1, TBDY: $esu1_{\text{nominal}} = 0.08$,

For calculation of $esu1_{\text{nominal}}$ and $y1, sh1, ft1, fy1$, it is considered
characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/d)^{2/3}), \text{ from } 10.3.5, \text{ ASCE } 41-17.$$

$$\text{with } fs1 = (fs_{\text{jacket}} \cdot Asl, \text{ten, jacket} + fs_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 739.0086$$

$$\text{with } Es1 = (Es_{\text{jacket}} \cdot Asl, \text{ten, jacket} + Es_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 886.8103$$

$$fy2 = 739.0086$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \text{min} = lb/lb, \text{min} = 1.00$$

$$su2 = 0.4 \cdot esu2_{\text{nominal}} ((5.5), \text{TBDY}) = 0.032$$

From table 5A.1, TBDY: $esu2_{\text{nominal}} = 0.08$,

For calculation of $esu2_{\text{nominal}}$ and $y2, sh2, ft2, fy2$, it is considered
characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/d)^{2/3}), \text{ from } 10.3.5, \text{ ASCE } 41-17.$$

$$\text{with } fs2 = (fs_{\text{jacket}} \cdot Asl, \text{com, jacket} + fs_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 739.0086$$

$$\text{with } Es2 = (Es_{\text{jacket}} \cdot Asl, \text{com, jacket} + Es_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 895.9746$$

$$fyv = 746.6455$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \text{min} = lb/d = 1.00$$

$$suv = 0.4 \cdot esuv_{\text{nominal}} ((5.5), \text{TBDY}) = 0.032$$

From table 5A.1, TBDY: $esuv_{\text{nominal}} = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_{\text{nominal}}$ and yv, shv, ftv, fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/d)^{2/3}), \text{ from } 10.3.5, \text{ ASCE } 41-17.$$

$$\text{with } fsv = (fs_{\text{jacket}} \cdot Asl, \text{mid, jacket} + fs_{\text{mid}} \cdot Asl, \text{mid, core}) / Asl, \text{mid} = 746.6455$$

$$\text{with } Esv = (Es_{\text{jacket}} \cdot Asl, \text{mid, jacket} + Es_{\text{mid}} \cdot Asl, \text{mid, core}) / Asl, \text{mid} = 200000.00$$

$$1 = Asl, \text{ten} / (b \cdot d) \cdot (fs1 / fce) = 0.09382814$$

$$2 = A_{sl,com}/(b*d)*(f_s2/f_c) = 0.09382814$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05785932$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 30.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.11251192$$

$$2 = A_{sl,com}/(b*d)*(f_s2/f_c) = 0.11251192$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.06938071$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.1468828$$

$$M_u = M_{Rc} (4.14) = 3.2725E+008$$

$$u = s_u (4.1) = 0.00010507$$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of M_{u2+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 0.00010507$$

$$M_u = 3.2725E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.0053097$$

$$w_e (5.4c) = 0.00204688$$

$$a_{se} ((5.4d), TBDY) = (a_{se1}*A_{ext} + a_{se2}*A_{int})/A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh,min}*F_{ywe} = \text{Min}(p_{sh,x}*F_{ywe}, p_{sh,y}*F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $p_{sh,min}*F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh_x}*F_{ywe} = p_{sh1}*F_{ywe1} + p_{sh2}*F_{ywe2} = 2.45559$$

$$p_{s1} (\text{external}) = (A_{sh1}*h_1/s_1)/A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1}*n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} (\text{internal}) = (A_{sh2}*h_2/s_2)/A_{sec} = 0.00062519$$

Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.38519
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 781.25

fywe2 = 656.25

fce = 30.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 886.8103

fy1 = 739.0086

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 739.0086

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025

sh2 = 0.008

ft2 = 886.8103

fy2 = 739.0086

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 895.9746

fyv = 746.6455

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered

characteristic value $f_{sv} = f_{sv}/1.2$, 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 $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 746.6455$

with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.09382814$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.09382814$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.05785932$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

f_{cc} (5A.2, TBDY) = 30.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.11251192$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.11251192$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.06938071$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

---->

su (4.9) = 0.1468828

$Mu = MRc$ (4.14) = 3.2725E+008

$u = su$ (4.1) = 0.00010507

Calculation of ratio lb/ld

Adequate Lap Length: $lb/ld \geq 1$

Calculation of Mu_2 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 0.00010507$

$Mu = 3.2725E+008$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.0003219$

$N = 2309.833$

$f_c = 30.00$

co (5A.5, TBDY) = 0.002

Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.0053097$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $cu = 0.0053097$

we (5.4c) = 0.00204688

ase ((5.4d), TBDY) = $(ase_1 \cdot A_{ext} + ase_2 \cdot A_{int}) / A_{sec} = 0.14776895$

$ase_1 = 0.14776895$

$bo_1 = 340.00$

$ho_1 = 610.00$

$bi_2_1 = 975400.00$

$ase_2 = \text{Max}(ase_1, ase_2) = 0.14776895$

$bo_2 = 192.00$

$ho_2 = 492.00$

$bi_2_2 = 557856.00$

$psh_{min} \cdot F_{ywe} = \text{Min}(psh_x \cdot F_{ywe}, psh_y \cdot F_{ywe}) = 1.38519$

Expression ((5.4d), TBDY) for $psh_{min} \cdot F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $psh_x \cdot F_{ywe} = psh_1 \cdot F_{ywe1} + ps_2 \cdot F_{ywe2} = 2.45559$

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 = 1.38519
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 = 781.25
fywe2 = 656.25
fce = 30.00

From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00

y1 = 0.0025
sh1 = 0.008
ft1 = 886.8103
fy1 = 739.0086
su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

su1 = $0.4 \cdot esu1_nominal$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1, ft1, fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1, ft1, fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = $(fs_jacket \cdot Asl,ten,jacket + fs_core \cdot Asl,ten,core) / Asl,ten = 739.0086$

with Es1 = $(Es_jacket \cdot Asl,ten,jacket + Es_core \cdot Asl,ten,core) / Asl,ten = 200000.00$

y2 = 0.0025
sh2 = 0.008
ft2 = 886.8103
fy2 = 739.0086
su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = $0.4 \cdot esu2_nominal$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2, ft2, fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1, ft1, fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = $(fs_jacket \cdot Asl,com,jacket + fs_core \cdot Asl,com,core) / Asl,com = 739.0086$

with Es2 = $(Es_jacket \cdot Asl,com,jacket + Es_core \cdot Asl,com,core) / Asl,com = 200000.00$

yv = 0.0025
shv = 0.008
ftv = 895.9746
fyv = 746.6455
suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_0/l_{ou,min} = l_b/l_d = 1.00$$

$$s_{uv} = 0.4 * e_{suv_nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{suv_nominal} = 0.08$,

considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY

For calculation of $e_{suv_nominal}$ and γ_v , sh_v, ft_v, fy_v , it is considered

characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.

$$\gamma_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b/l_d)^{2/3}), \text{ from } 10.3.5, \text{ ASCE } 41-17.$$

$$\text{with } f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 746.6455$$

$$\text{with } E_{sv} = (E_{s,jacket} * A_{s,mid,jacket} + E_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 200000.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.09382814$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.09382814$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.05785932$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 30.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.11251192$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.11251192$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.06938071$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

---->

$$s_u (4.9) = 0.1468828$$

$$\mu_u = M_{Rc} (4.14) = 3.2725E+008$$

$$u = s_u (4.1) = 0.00010507$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 390183.487$

Calculation of Shear Strength at edge 1, $V_{r1} = 390183.487$

$$V_{r1} = V_n ((22.5.1.1), \text{ACI } 318-14)$$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f^*V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

$$\text{From Table } (22.5.5.1), \text{ACI } 318-14: V_c = 180743.977$$

$$= 1 \text{ (normal-weight concrete)}$$

$$\text{Mean concrete strength: } f'_c = (f'_{c,jacket} * \text{Area}_{jacket} + f'_{c,core} * \text{Area}_{core}) / \text{Area}_{section} = 27.76119, \text{ but } f_c^{0.5} < = 8.3 \text{ MPa } (22.5.3.1, \text{ACI } 318-14)$$

$$p_w = A_s / (b_w * d) = 0.00331157$$

$$A_s \text{ (tension reinf.)} = 709.9999$$

$$b_w = 670.00$$

$$d = 320.00$$

$$V_u * d / \mu_u < 1 = 0.00$$

$$\mu_u = 6.8565666E-012$$

$$V_u = 9.0372119E-015$$

$$\text{From } (11.5.4.8), \text{ACI } 318-14: V_{s1} + V_{s2} = 209439.51$$

$V_{s1} = 209439.51$ is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 625.00$$

$$s = 150.00$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 0.00$ is calculated for jacket, with:

$$d_2 = 160.00$$

$$A_v = 100530.965$$

$$f_y = 525.00$$

$$s = 300.00$$

Vs2 is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

$$V_f \text{ ((11-3)-(11.4), ACI 440)} = 0.00$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 750430.726$$

Calculation of Shear Strength at edge 2, $V_{r2} = 390183.487$

$$V_{r2} = V_n \text{ ((22.5.1.1), ACI 318-14)}$$

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw + f*Vf'

where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_c \text{_{jacket}} * \text{Area}_{\text{jacket}} + f'_c \text{_{core}} * \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 27.76119$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$$p_w = A_s / (b_w * d) = 0.00331157$$

$$A_s \text{ (tension reinf.)} = 709.9999$$

$$b_w = 670.00$$

$$d = 320.00$$

$$V_u * d / \mu_u < 1 = 0.00$$

$$\mu_u = 2.0256286E-011$$

$$V_u = 9.0372119E-015$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$

$V_{s1} = 209439.51$ is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 625.00$$

$$s = 150.00$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 0.00$ is calculated for jacket, with:

$$d = 160.00$$

$$A_v = 100530.965$$

$$f_y = 525.00$$

$$s = 300.00$$

Vs2 is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

$$V_f \text{ ((11-3)-(11.4), ACI 440)} = 0.00$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 750430.726$$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor, = 0.87

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_b/d \geq 1$)
No FRP Wrapping

Stepwise Properties

Bending Moment, M = 1.1729E+007
Shear Force, V2 = -1.3365595E-014
Shear Force, V3 = 15636.882
Axial Force, F = -7187.067
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Asl,ten = 709.9999
-Compression: Asl,com = 1668.186
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 709.9999
-Compression: Asl,com = 1266.062
-Middle: Asl,mid = 402.1239
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 402.1239
-Compression: Asl,com,jacket = 804.2477
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 307.8761
-Compression: Asl,com,core = 461.8141
-Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 15.00

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_{R} = \alpha u = 0.00953983$
 $u = y + p = 0.01096532$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00096532$ ((4.29), Biskinis Phd))
 $M_y = 2.9231E+008$
 $L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 750.0686
From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 7.5708E+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 5.8234894E-006$
with $f_y = 625.00$
 $d = 627.00$
 $y = 0.18846591$
 $A = 0.00953075$
 $B = 0.00408216$
with $p_t = 0.00283094$
 $p_c = 0.00504809$

$p_v = 0.00160336$
 $N = 7187.067$
 $b = 400.00$
 $" = 0.06858054$
 $y_{comp} = 1.7825671E-005$
 with $f_c = 27.76119$
 $E_c = 25742.96$
 $y = 0.18768166$
 $A = 0.00941409$
 $B = 0.0040338$
 with $E_s = 200000.00$

 Calculation of ratio I_b/I_d

 Adequate Lap Length: $I_b/I_d \geq 1$

 - Calculation of p -

 From table 10-7: $p = 0.01$

with:

- Condition i occurred

Beam controlled by flexure: $V_p/V_o \leq 1$

shear control ratio $V_p/V_o = 0.92480584$

- Transverse Reinforcement: C

- Stirrup Spacing $\leq d/3$

- Low ductility demand, $\lambda / y < 2$ (table 10-6, ASCE 41-17)

$= 4.9940864E-006$

- Stirrup Spacing $\leq d/2$

$d = d_{external} = 627.00$

$s = s_{external} = 150.00$

- Strength provided by hoops $V_s < 3/4 * \text{design Shear}$

$V_s = 421182.855$, already given in calculation of shear control ratio

design Shear = 15636.882

- ($\rho' - \rho$) / $\rho_{bal} = -0.3178459$

$= A_{st}/(b_w*d) = 0.00283094$

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: $\rho_{bal} = 0.01202003$

$f_c = (f_{c_jacket} * \text{Area}_{jacket} + f_{c_core} * \text{Area}_{core}) / \text{section_area} = 27.76119$

$f_y = f_{y_jacket_bars} = 625.00$

From 10.2.7.3, ACI 318-11: $\lambda = 0.65$

From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + y) = 0.48979592$

$y = 0.003125$

- $V / (b_w*d*f_c^{0.5}) = 0.14250391$, NOTE: units in lb & in

$b_w = 400.00$

 End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Calculation No. 7

beam B1, Floor 1

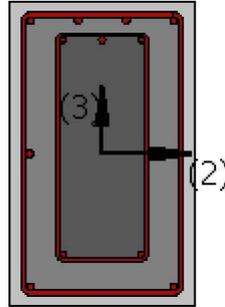
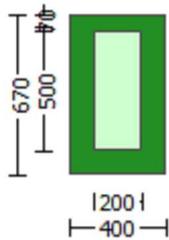
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity 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, $\gamma = 0.87$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 420.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou, \min} = l_b/l_d \geq 1$)

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 5.6604E+006$
Shear Force, $V_a = 4044.385$
EDGE -B-
Bending Moment, $M_b = 1.1729E+007$
Shear Force, $V_b = 15636.882$
BOTH EDGES
Axial Force, $F = -7187.067$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 709.9999$
-Compression: $A_{sc} = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten} = 709.9999$
-Compression: $A_{sc,com} = 1266.062$
-Middle: $A_{sc,mid} = 402.1239$
Mean Diameter of Tension Reinforcement, $D_{bL,ten} = 15.00$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = \phi V_n = 404549.731$
 V_n ((22.5.1.1), ACI 318-14) = 464999.69

NOTE: In expression (22.5.1.1) 'V_w' is replaced by 'V_w + ϕV_f '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 156202.077$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c,jacket} \cdot Area_{jacket} + f'_{c,core} \cdot Area_{core}) / Area_{section} = 18.50746$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu < 1 = 0.71460132$
 $\mu = 1.1729E+007$
 $V_u = 15636.882$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 308797.614$
 $V_{s1} = 280648.944$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 500.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 28148.67$ is calculated for core, with:
 $d = 400.00$
 $A_v = 100530.965$
 $f_y = 420.00$
 $s = 300.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 612724.122$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1
At local axis: 3
Integration Section: (b)

Calculation No. 8

beam B1, Floor 1

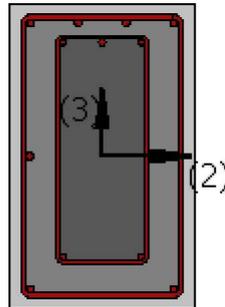
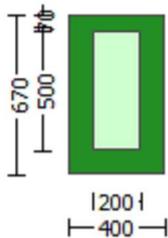
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (θ)

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 0.87$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 656.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.00
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_o/l_{ou}, \min >= 1$)
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, $V_a = 9840.634$
EDGE -B-
Shear Force, $V_b = 9840.632$
BOTH EDGES
Axial Force, $F = -2309.833$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 709.9999$
-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, $V_e/V_r = 0.92480584$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 535287.788$
with
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 7.8817E+008$
 $\mu_{u1+} = 4.6479E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{u1-} = 7.8817E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 7.8817E+008$
 $\mu_{u2+} = 4.6479E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{u2-} = 7.8817E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = 9840.634$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 9840.632$, is the shear force acting at edge 2 for the static loading combination

Calculation of μ_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 5.6369735E-005$
 $\mu_u = 4.6479E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.000307$
 $N = 2309.833$

$$f_c = 30.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.0053097$$

$$w_e \text{ (5.4c)} = 0.00204688$$

$$\text{ase ((5.4d), TBDY)} = (\text{ase1} * A_{ext} + \text{ase2} * A_{int}) / A_{sec} = 0.14776895$$

$$\text{ase1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\text{ase2} = \text{Max}(\text{ase1}, \text{ase2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\text{psh}_{\min} * F_{ywe} = \text{Min}(\text{psh}_x * F_{ywe}, \text{psh}_y * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $\text{psh}_{\min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\text{psh}_x * F_{ywe} = \text{psh1} * F_{ywe1} + \text{ps2} * F_{ywe2} = 2.45559$$

$$\text{ps1 (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\text{ps2 (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\text{psh}_y * F_{ywe} = \text{psh1} * F_{ywe1} + \text{ps2} * F_{ywe2} = 1.38519$$

$$\text{ps1 (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\text{ps2 (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 872.4558$$

$$fy_1 = 727.0465$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o / l_{ou, \min} = l_b / l_d = 1.00$$

$$su_1 = 0.4 * esu_{1, \text{nominal}} \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu_{1, \text{nominal}} = 0.08,$$

For calculation of $esu_{1, \text{nominal}}$ 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.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b / l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 727.0465$$

$$\text{with } Es_1 = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$$

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 882.7854$$

$$fy_2 = 735.6545$$

$$su_2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_o/l_{o,min} = l_b/l_{b,min} = 1.00$$

$$su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,

For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $fs_2 = fs_2/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 735.6545$$

$$\text{with } Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 937.50$$

$$fy_v = 781.25$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_o/l_{o,min} = l_b/l_d = 1.00$$

$$suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,

considering characteristic value $fs_v = fs_v/1.2$, 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 $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_v = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 781.25$$

$$\text{with } Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$$

$$1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.06860752$$

$$2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.12378842$$

$$v = A_{sl,mid} / (b * d) * (fs_v / fc) = 0.04175429$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 30.00$$

$$cc (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.08477074$$

$$2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.15295169$$

$$v = A_{sl,mid} / (b * d) * (fs_v / fc) = 0.05159117$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$su (4.9) = 0.09460844$$

$$Mu = MRc (4.14) = 4.6479E+008$$

$$u = su (4.1) = 5.6369735E-005$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Mu_1 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 6.0907698E-005$$

$$Mu = 7.8817E+008$$

with full section properties:

b = 400.00
d = 627.00
d' = 43.00
v = 0.000307
N = 2309.833
fc = 30.00
co (5A.5, TBDY) = 0.002

Final value of cu: $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0053097$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $cu = 0.0053097$

we (5.4c) = 0.00204688

ase ((5.4d), TBDY) = $(ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$

ase1 = 0.14776895

bo_1 = 340.00

ho_1 = 610.00

bi2_1 = 975400.00

ase2 = $\text{Max}(ase1, ase2) = 0.14776895$

bo_2 = 192.00

ho_2 = 492.00

bi2_2 = 557856.00

$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.38519$

Expression ((5.4d), TBDY) for $psh_{min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.45559$

ps1 (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

 $psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.38519$

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 = 781.25

fywe2 = 656.25

fce = 30.00

From ((5.A.5), TBDY), TBDY: $cc = 0.002$

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 882.7854

fy1 = 735.6545

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

su1 = $0.4 * esu1_{nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu1_{nominal} = 0.08$,

For calculation of $esu1_{nominal}$ and y1, sh1, ft1, fy1, it is considered characteristic value $fsy1 = fs1 / 1.2$, from table 5.1, TBDY.

y1, sh1, ft1, fy1, are also multiplied by $\text{Min}(1, 1.25 * (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 735.6545$

$$\text{with } E_{s1} = (E_{s,jacket} \cdot A_{s1,ten,jacket} + E_{s,core} \cdot A_{s1,ten,core}) / A_{s1,ten} = 200000.00$$

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 872.4558$$

$$fy_2 = 727.0465$$

$$su_2 = 0.032$$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

$$l_0/l_{ou,min} = l_b/l_{b,min} = 1.00$$

$$su_2 = 0.4 \cdot esu_2 \text{ nominal } ((5.5), \text{ TBDY}) = 0.032$$
 From table 5A.1, TBDY: $esu_2 \text{ nominal} = 0.08$,
 For calculation of $esu_2 \text{ nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fs_2 = fs_2 / 1.2$, 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.

$$\text{with } fs_2 = (fs_{jacket} \cdot A_{s1,com,jacket} + fs_{core} \cdot A_{s1,com,core}) / A_{s1,com} = 727.0465$$

$$\text{with } E_{s2} = (E_{s,jacket} \cdot A_{s1,com,jacket} + E_{s,core} \cdot A_{s1,com,core}) / A_{s1,com} = 200000.00$$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 937.50$$

$$fy_v = 781.25$$

$$su_v = 0.032$$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

$$l_0/l_{ou,min} = l_b / l_d = 1.00$$

$$su_v = 0.4 \cdot esuv \text{ nominal } ((5.5), \text{ TBDY}) = 0.032$$
 From table 5A.1, TBDY: $esuv \text{ nominal} = 0.08$,
 considering characteristic value $fs_v = fs_v / 1.2$, from table 5.1, TBDY
 For calculation of $esuv \text{ nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fs_v = fs_v / 1.2$, 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.

$$\text{with } fs_v = (fs_{jacket} \cdot A_{s1,mid,jacket} + fs_{mid} \cdot A_{s1,mid,core}) / A_{s1,mid} = 781.25$$

$$\text{with } E_{sv} = (E_{s,jacket} \cdot A_{s1,mid,jacket} + E_{s,mid} \cdot A_{s1,mid,core}) / A_{s1,mid} = 200000.00$$

$$1 = A_{s1,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.12378842$$

$$2 = A_{s1,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.06860752$$

$$v = A_{s1,mid} / (b \cdot d) \cdot (fs_v / fc) = 0.04175429$$
 and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc \text{ (5A.2, TBDY)} = 30.00$$

$$cc \text{ (5A.5, TBDY)} = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{s1,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.15295169$$

$$2 = A_{s1,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.08477074$$

$$v = A_{s1,mid} / (b \cdot d) \cdot (fs_v / fc) = 0.05159117$$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

---->
 $v < v_{s,y2}$ - LHS eq.(4.5) is not satisfied

---->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied

---->
 $su \text{ (4.8)} = 0.16206515$
 $Mu = MRc \text{ (4.15)} = 7.8817E+008$
 $u = su \text{ (4.1)} = 6.0907698E-005$

 Calculation of ratio l_b / l_d

 Adequate Lap Length: $l_b / l_d \geq 1$

 Calculation of Mu_{2+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 5.6369735E-005$$

$$\mu = 4.6479E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_o (5A.5, TBDY) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.0053097$$

$$\phi_{we} (5.4c) = 0.00204688$$

$$\text{ase ((5.4d), TBDY) } = (\text{ase}_1 * A_{ext} + \text{ase}_2 * A_{int}) / A_{sec} = 0.14776895$$

$$\text{ase}_1 = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\text{ase}_2 = \text{Max}(\text{ase}_1, \text{ase}_2) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\phi_{psh,min} * F_{ywe} = \text{Min}(\phi_{psh,x} * F_{ywe}, \phi_{psh,y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $\phi_{psh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{psh,x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 2.45559$$

$$\phi_{psh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{psh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{psh,y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 1.38519$$

$$\phi_{psh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{psh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 872.4558$$

$$fy_1 = 727.0465$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o/l_{o,u,min} = l_b/l_d = 1.00$$

$$s_u1 = 0.4 * e_{s1_nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{s1_nominal} = 0.08$,

For calculation of $e_{s1_nominal}$ and y_1, sh_1, ft_1, 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.

$$\text{with } f_{s1} = (f_{s,jacket} * A_{s,ten,jacket} + f_{s,core} * A_{s,ten,core}) / A_{s,ten} = 727.0465$$

$$\text{with } E_{s1} = (E_{s,jacket} * A_{s,ten,jacket} + E_{s,core} * A_{s,ten,core}) / A_{s,ten} = 200000.00$$

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 882.7854$$

$$fy_2 = 735.6545$$

$$s_u2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$$l_o/l_{o,u,min} = l_b/l_{b,min} = 1.00$$

$$s_u2 = 0.4 * e_{s2_nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{s2_nominal} = 0.08$,

For calculation of $e_{s2_nominal}$ and y_2, sh_2, ft_2, 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.

$$\text{with } f_{s2} = (f_{s,jacket} * A_{s,com,jacket} + f_{s,core} * A_{s,com,core}) / A_{s,com} = 735.6545$$

$$\text{with } E_{s2} = (E_{s,jacket} * A_{s,com,jacket} + E_{s,core} * A_{s,com,core}) / A_{s,com} = 200000.00$$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 937.50$$

$$fy_v = 781.25$$

$$s_uv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$$l_o/l_{o,u,min} = l_b/l_d = 1.00$$

$$s_uv = 0.4 * e_{suv_nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{suv_nominal} = 0.08$,

considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY

For calculation of $e_{suv_nominal}$ and y_v, sh_v, ft_v, 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.

$$\text{with } f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 781.25$$

$$\text{with } E_{sv} = (E_{s,jacket} * A_{s,mid,jacket} + E_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 200000.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.06860752$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.12378842$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.04175429$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 30.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.08477074$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.15295169$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.05159117$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.09460844$$

$$Mu = MR_c (4.14) = 4.6479E+008$$

$$u = s_u (4.1) = 5.6369735E-005$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Mu2-

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\mu = 6.0907698E-005$$

$$Mu = 7.8817E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.0053097$$

$$w_e \text{ (5.4c)} = 0.00204688$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.45559$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.38519$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 882.7854$$

$$fy1 = 735.6545$$

$$su1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou,min = lb/ld = 1.00$$

$$su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 735.6545$$

$$\text{with } Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 872.4558$$

$$fy2 = 727.0465$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou,min = lb/lb,min = 1.00$$

$$su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 727.0465$$

$$\text{with } Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 937.50$$

$$fyv = 781.25$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou,min = lb/ld = 1.00$$

$$suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 781.25$$

$$\text{with } Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$$

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.12378842$$

$$2 = Asl,com/(b*d)*(fs2/fc) = 0.06860752$$

$$v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 30.00$$

$$cc (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.15295169$$

$$2 = Asl,com/(b*d)*(fs2/fc) = 0.08477074$$

$$v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

v < vs,y2 - LHS eq.(4.5) is not satisfied

---->

v < vs,c - RHS eq.(4.5) is satisfied

---->

$$su (4.8) = 0.16206515$$

$$\begin{aligned} \mu &= MRC(4.15) = 7.8817E+008 \\ u &= su(4.1) = 6.0907698E-005 \end{aligned}$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 578810.994$

Calculation of Shear Strength at edge 1, $V_{r1} = 578810.994$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'V_w' is replaced by 'V_w + f*V_f'
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 192813.976$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} * Area_jacket + f'_{c_core} * Area_core) / Area_section = 27.76119$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w * d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u * d / \mu < 1 = 1.00$
 $\mu = 1.1510E+006$
 $V_u = 9840.634$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 385997.017$
 $V_{s1} = 350811.18$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 35185.838$ is calculated for jacket, with:
 $d_2 = 400.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

Calculation of Shear Strength at edge 2, $V_{r2} = 578810.994$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'V_w' is replaced by 'V_w + f*V_f'
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 192813.976$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} * Area_jacket + f'_{c_core} * Area_core) / Area_section = 27.76119$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w * d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u * d / \mu < 1 = 1.00$
 $\mu = 1.1510E+006$
 $V_u = 9840.632$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 385997.017$
 $V_{s1} = 350811.18$ is calculated for jacket, with:
 $d = 536.00$

Av = 157079.633
fy = 625.00
s = 150.00

Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
Vs2 = 35185.838 is calculated for jacket, with:

d = 400.00
Av = 100530.965
fy = 525.00
s = 300.00

Vs2 has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $Vs + Vf \leq 750430.726$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjars

Constant Properties

Knowledge Factor, = 0.87

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, $f_s = 1.25 * f_{sm} = 781.25$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 * f_{sm} = 656.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou}, \min > = 1$)

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = -9.0372119E-015$

EDGE -B-

Shear Force, $V_b = 9.0372119E-015$

BOTH EDGES

Axial Force, $F = -2309.833$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 709.9999$

-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 , $V_e/V_r = 0.55914272$

Member Controlled by Flexure ($V_e/V_r < 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n / 2 = 218168.257$

with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 3.2725E+008$

$M_{u1+} = 3.2725E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$M_{u1-} = 3.2725E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 3.2725E+008$

$M_{u2+} = 3.2725E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

$M_{u2-} = 3.2725E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

and

$\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$

with

$V_1 = -9.0372119E-015$, is the shear force acting at edge 1 for the the static loading combination

$V_2 = 9.0372119E-015$, is the shear force acting at edge 2 for the the static loading combination

Calculation of M_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$\phi_u = 0.00010507$

$M_u = 3.2725E+008$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.0003219$

$N = 2309.833$

$f_c = 30.00$

α (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0053097$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\phi_u = 0.0053097$

w_e (5.4c) = 0.00204688

a_{se} ((5.4d), TBDY) = $(a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int}) / A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o_1} = 340.00$

$h_{o_1} = 610.00$

$b_{i2_1} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o_2} = 192.00$

$h_{o_2} = 492.00$

$b_{i2_2} = 557856.00$

$$psh_{min} * Fy_{we} = \text{Min}(psh_x * Fy_{we}, psh_y * Fy_{we}) = 1.38519$$

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)

$$psh_x * Fy_{we} = psh_1 * Fy_{we1} + ps_2 * Fy_{we2} = 2.45559$$

$$ps_1 \text{ (external)} = (Ash_1 * h_1 / s_1) / A_{sec} = 0.00261799$$

$$Ash_1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h_1 = 670.00$$

$$ps_2 \text{ (internal)} = (Ash_2 * h_2 / s_2) / A_{sec} = 0.00062519$$

$$Ash_2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h_2 = 500.00$$

$$psh_y * Fy_{we} = psh_1 * Fy_{we1} + ps_2 * Fy_{we2} = 1.38519$$

$$ps_1 \text{ (external)} = (Ash_1 * h_1 / s_1) / A_{sec} = 0.00156298$$

$$Ash_1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h_1 = 400.00$$

$$ps_2 \text{ (internal)} = (Ash_2 * h_2 / s_2) / A_{sec} = 0.00025008$$

$$Ash_2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$fy_{we1} = 781.25$$

$$fy_{we2} = 656.25$$

$$f_{ce} = 30.00$$

From ((5.A5), TBDY), TBDY: $cc = 0.002$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 886.8103$$

$$fy_1 = 739.0086$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$lo/lo_{min} = lb/lb_{min} = 1.00$$

$$su_1 = 0.4 * esu_{1_nominal} \text{ ((5.5), TBDY)} = 0.032$$

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 $\text{Min}(1, 1.25 * (lb/lb_{min})^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 739.0086$$

$$\text{with } Es_1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$$

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 886.8103$$

$$fy_2 = 739.0086$$

$$su_2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$lo/lo_{min} = lb/lb_{min} = 1.00$$

$$su_2 = 0.4 * esu_{2_nominal} \text{ ((5.5), TBDY)} = 0.032$$

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 $\text{Min}(1, 1.25 * (lb/lb_{min})^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 739.0086$$

$$\text{with } Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 895.9746$$

$$f_{yv} = 746.6455$$

$$s_{uv} = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_o/l_{ou,min} = l_b/l_d = 1.00$$

$$s_{uv} = 0.4 * e_{suv,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{suv,nominal} = 0.08$,

considering characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY

For calculation of $e_{suv,nominal}$ and γ_v , sh_v, ft_v, f_{yv} , it is considered
characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.

$$\gamma_1, sh_1, ft_1, f_{y1}, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b/l_d)^{2/3}), \text{ from } 10.3.5, \text{ ASCE } 41-17.$$

$$\text{with } f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 746.6455$$

$$\text{with } E_{sv} = (E_{s,jacket} * A_{s,mid,jacket} + E_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 200000.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.09382814$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.09382814$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.05785932$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 30.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.11251192$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.11251192$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.06938071$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

---->

$$s_u (4.9) = 0.1468828$$

$$\mu_u = M_{Rc} (4.14) = 3.2725E+008$$

$$u = s_u (4.1) = 0.00010507$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of μ_u 1-

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 0.00010507$$

$$\mu_u = 3.2725E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_o (5A.5, TBDY) = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.0053097$$

$$w_e (5.4c) = 0.00204688$$

$$\text{ase} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.38519

Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.45559
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.38519
ps1 (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 = 781.25
fywe2 = 656.25
fce = 30.00

From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00

y1 = 0.0025
sh1 = 0.008
ft1 = 886.8103
fy1 = 739.0086
su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by 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 = 739.0086

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025
sh2 = 0.008
ft2 = 886.8103
fy2 = 739.0086
su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb,min)^ 2/3), from 10.3.5, ASCE 41-17.

with $f_{s2} = (f_{s,jacket} \cdot A_{s,com,jacket} + f_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 739.0086$
 with $E_{s2} = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 200000.00$
 $y_v = 0.0025$
 $sh_v = 0.008$
 $ft_v = 895.9746$
 $fy_v = 746.6455$
 $suv = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 1.00$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 746.6455$
 with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.09382814$
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.09382814$
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.05785932$

and confined core properties:

$b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.11251192$
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.11251192$
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.06938071$

Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

$su (4.9) = 0.1468828$
 $Mu = MR_c (4.14) = 3.2725E+008$
 $u = su (4.1) = 0.00010507$

 Calculation of ratio l_b/l_d

 Adequate Lap Length: $l_b/l_d \geq 1$

 Calculation of Mu_{2+}

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 0.00010507$
 $Mu = 3.2725E+008$

 with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.0003219$
 $N = 2309.833$
 $f_c = 30.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu^* = shear_factor * $\text{Max}(cu, cc) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0053097$

w_e (5.4c) = 0.00204688
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$

$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.38519$

Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.45559$
 p_{s1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 670.00$
 p_{s2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.38519$
 p_{s1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 p_{s2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$A_{sec} = 268000.00$

$s_1 = 150.00$

$s_2 = 300.00$

$f_{ywe1} = 781.25$

$f_{ywe2} = 656.25$

$f_{ce} = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$

$c =$ confinement factor = 1.00

$y_1 = 0.0025$

$sh_1 = 0.008$

$ft_1 = 886.8103$

$fy_1 = 739.0086$

$su_1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$l_o / l_{ou, \min} = l_b / l_d = 1.00$

$su_1 = 0.4 * esu_{1, \text{nominal}} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu_{1, \text{nominal}} = 0.08$,

For calculation of $esu_{1, \text{nominal}}$ and y_1, sh_1, ft_1, fy_1 , it is considered characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_1 = (f_{s, \text{jacket}} * A_{s1, \text{ten, jacket}} + f_{s, \text{core}} * A_{s1, \text{ten, core}}) / A_{s1, \text{ten}} = 739.0086$

with $Es_1 = (E_{s, \text{jacket}} * A_{s1, \text{ten, jacket}} + E_{s, \text{core}} * A_{s1, \text{ten, core}}) / A_{s1, \text{ten}} = 200000.00$

$y_2 = 0.0025$

$sh_2 = 0.008$

$ft_2 = 886.8103$

$fy_2 = 739.0086$

$su_2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$l_o / l_{ou, \min} = l_b / l_{b, \min} = 1.00$

$$su_2 = 0.4 * esu_{2_nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esu_{2_nominal} = 0.08$,

For calculation of $esu_{2_nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered characteristic value $fs_2 = fs_2/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_2 = (fs_{jacket} * Asl_{,com,jacket} + fs_{core} * Asl_{,com,core}) / Asl_{,com} = 739.0086$$

$$\text{with } Es_2 = (Es_{jacket} * Asl_{,com,jacket} + Es_{core} * Asl_{,com,core}) / Asl_{,com} = 200000.00$$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 895.9746$$

$$fy_v = 746.6455$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$lo/lo_{u,min} = lb/ld = 1.00$$

$$suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,

considering characteristic value $fs_v = fs_v/1.2$, 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 $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_v = (fs_{jacket} * Asl_{,mid,jacket} + fs_{mid} * Asl_{,mid,core}) / Asl_{,mid} = 746.6455$$

$$\text{with } Es_v = (Es_{jacket} * Asl_{,mid,jacket} + Es_{mid} * Asl_{,mid,core}) / Asl_{,mid} = 200000.00$$

$$1 = Asl_{,ten} / (b * d) * (fs_1 / fc) = 0.09382814$$

$$2 = Asl_{,com} / (b * d) * (fs_2 / fc) = 0.09382814$$

$$v = Asl_{,mid} / (b * d) * (fs_v / fc) = 0.05785932$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 30.00$$

$$cc (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = Asl_{,ten} / (b * d) * (fs_1 / fc) = 0.11251192$$

$$2 = Asl_{,com} / (b * d) * (fs_2 / fc) = 0.11251192$$

$$v = Asl_{,mid} / (b * d) * (fs_v / fc) = 0.06938071$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

--->

$$su (4.9) = 0.1468828$$

$$Mu = MRc (4.14) = 3.2725E+008$$

$$u = su (4.1) = 0.00010507$$

Calculation of ratio lb/ld

Adequate Lap Length: $lb/ld \geq 1$

Calculation of Mu_2 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 0.00010507$$

$$Mu = 3.2725E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.0053097$$

$$w_e \text{ (5.4c)} = 0.00204688$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.45559$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.38519$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 886.8103$$

$$fy_1 = 739.0086$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o / l_{ou, \min} = l_b / l_d = 1.00$$

$$su_1 = 0.4 * e_{su1, \text{nominal}} \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } e_{su1, \text{nominal}} = 0.08,$$

For calculation of $e_{su1, \text{nominal}}$ and y_1, sh_1, ft_1, fy_1 , it is considered characteristic value $fs_1 = fs_1 / 1.2$, from table 5.1, TBDY.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b / l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 739.0086$$

$$\text{with } E_{s1} = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$$

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 886.8103$$

$$fy_2 = 739.0086$$

$$su_2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lo_{u,min} = lb/lb_{u,min} = 1.00$$

$$su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,

For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $fs_2 = fs_2/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 739.0086$$

$$\text{with } Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 895.9746$$

$$fyv = 746.6455$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lo_{u,min} = lb/ld = 1.00$$

$$suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$$

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 yv, shv, ftv, fyv , 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 $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 746.6455$$

$$\text{with } Esv = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$$

$$1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.09382814$$

$$2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.09382814$$

$$v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.05785932$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 30.00$$

$$cc (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.11251192$$

$$2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.11251192$$

$$v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.06938071$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

---->

$$su (4.9) = 0.1468828$$

$$\mu = MRc (4.14) = 3.2725E+008$$

$$u = su (4.1) = 0.00010507$$

Calculation of ratio lb/ld

Adequate Lap Length: $lb/ld \geq 1$

Calculation of Shear Strength $V_r = Min(V_{r1}, V_{r2}) = 390183.487$

Calculation of Shear Strength at edge 1, $V_{r1} = 390183.487$

$$V_{r1} = V_n ((22.5.1.1), ACI 318-14)$$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f * V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$
 $= 1$ (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot Area_jacket + f'_{c_core} \cdot Area_core) / Area_section = 27.76119$, but $f'_c^{0.5} < = 8.3$ MPa (22.5.3.1, ACI 318-14)
 $pw = A_s / (bw \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $bw = 670.00$
 $d = 320.00$
 $V_u \cdot d / \mu < 1 = 0.00$
 $\mu = 6.8565666E-012$
 $V_u = 9.0372119E-015$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:
 $d_2 = 160.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f < = 750430.726$

Calculation of Shear Strength at edge 2, $V_{r2} = 390183.487$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$
 $= 1$ (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot Area_jacket + f'_{c_core} \cdot Area_core) / Area_section = 27.76119$, but $f'_c^{0.5} < = 8.3$ MPa (22.5.3.1, ACI 318-14)
 $pw = A_s / (bw \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $bw = 670.00$
 $d = 320.00$
 $V_u \cdot d / \mu < 1 = 0.00$
 $\mu = 2.0256286E-011$
 $V_u = 9.0372119E-015$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:
 $d = 160.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f < = 750430.726$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3
Integration Section: (b)
Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$
New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$
Concrete Elasticity, $E_c = 25742.96$
Steel Elasticity, $E_s = 200000.00$
Existing Column
Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$
Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$
Concrete Elasticity, $E_c = 23025.204$
Steel Elasticity, $E_s = 200000.00$
External Height, $H = 670.00$
External Width, $W = 400.00$
Internal Height, $H = 500.00$
Internal Width, $W = 200.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_b/d >= 1$)
No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 2.3137405E-011$
Shear Force, $V_2 = -1.3365595E-014$
Shear Force, $V_3 = 15636.882$
Axial Force, $F = -7187.067$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl} = 709.9999$
-Compression: $A_{slc} = 1668.186$
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, $DbL = 15.20$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_{,R} = \gamma \cdot u = 0.00791936$
 $u = \gamma \cdot u + p = 0.00910271$

- Calculation of γ -

$y = (M_y * L_s / 3) / E_{eff} = 0.00410271$ ((4.29), Biskinis Phd))
My = 2.1250E+008
Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 2.5898E+013$

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

 $y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 1.0750434E-005$
with $f_y = 625.00$
d = 357.00
y = 0.22791811
A = 0.00999336
B = 0.00562082
with $p_t = 0.00380895$
pc = 0.00380895
pv = 0.00232477
N = 7187.067
b = 670.00
" = 0.12044818
 $y_{comp} = 2.5846388E-005$
with $f_c = 27.76119$
Ec = 25742.96
y = 0.22733547
A = 0.00987104
B = 0.00557012
with Es = 200000.00

Calculation of ratio lb/d

Adequate Lap Length: $lb/d \geq 1$

- Calculation of p -

From table 10-7: $p = 0.005$

with:

- Condition i occurred

Beam controlled by flexure: $V_p/V_o \leq 1$

shear control ratio $V_p/V_o = 0.55914272$

- Transverse Reinforcement: NC

- Stirrup Spacing > d/3

- Low ductility demand, $\lambda / y < 2$ (table 10-6, ASCE 41-17)

= -1.8338097E-023

- Stirrup Spacing $\leq d/2$

d = d_external = 357.00

s = s_external = 150.00

- Strength provided by hoops $V_s < 3/4 * \text{design Shear}$

$V_s = 237588.18$, already given in calculation of shear control ratio

design Shear = 1.3365595E-014

- ($\lambda - \lambda'$) / bal = -0.33327376

= $A_{st} / (b_w * d) = 0.00296835$

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 = 0.01202003

$f_c = (f_{c_jacket} * \text{Area}_{jacket} + f_{c_core} * \text{Area}_{core}) / \text{section_area} = 27.76119$

$f_y = f_{y_jacket_bars} = 625.00$

From 10.2.7.3, ACI 318-11: $\lambda = 0.65$

From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + y) = 0.48979592$

y = 0.003125

- $V / (b_w * d * f_c^{0.5}) = 1.2771721E-019$, NOTE: units in lb & in

$bw = 670.00$

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)

Calculation No. 9

beam B1, Floor 1

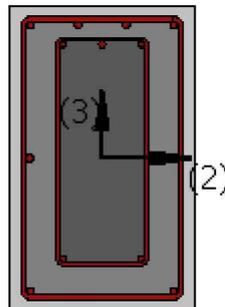
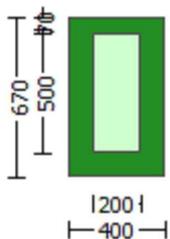
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 420.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$
External Height, $H = 670.00$
External Width, $W = 400.00$
Internal Height, $H = 500.00$
Internal Width, $W = 200.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_o/l_{ou,min} = l_b/l_d \geq 1$)
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, $M_a = 2.8583610E-011$
Shear Force, $V_a = 2.4489115E-014$
EDGE -B-
Bending Moment, $M_b = 4.4683392E-011$
Shear Force, $V_b = -2.4489115E-014$
BOTH EDGES
Axial Force, $F = -9608.729$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 709.9999$
-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: $A_{st,mid} = 556.0619$
Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 15.20$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = \phi V_n = 274161.749$
 V_n ((22.5.1.1), ACI 318-14) = 315128.448

NOTE: In expression (22.5.1.1) 'V_w' is replaced by 'V_w + φV_f'
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 147576.839$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_c \text{ jacket} * \text{Area jacket} + f'_c \text{ core} * \text{Area core}) / \text{Area section} = 18.50746$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w * d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u * d / M_u < 1 = 0.00$
 $M_u = 2.8583610E-011$
 $V_u = 2.4489115E-014$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 167551.608$
 $V_{s1} = 167551.608$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 500.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 0.00$ is calculated for core, with:
 $d = 160.00$
 $A_v = 100530.965$
 $f_y = 420.00$
 $s = 300.00$

Vs2 is considered 0 ($s > d$, according to ASCE 41-17, 10.3.4)

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 612724.122$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (a)

Calculation No. 10

beam B1, Floor 1

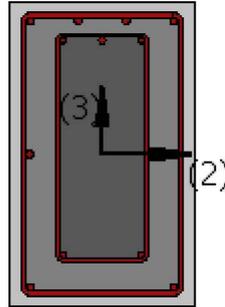
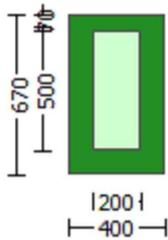
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (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, $\gamma = 0.87$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 656.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou, \min} > 1$)

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 9840.634$

EDGE -B-

Shear Force, $V_b = 9840.632$

BOTH EDGES

Axial Force, $F = -2309.833$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 709.9999$

-Compression: $A_{sc} = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{st, \text{ten}} = 709.9999$

-Compression: $A_{st, \text{com}} = 1266.062$

-Middle: $A_{st, \text{mid}} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.92480584$

Member Controlled by Flexure ($V_e/V_r < 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 535287.788$

with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 7.8817E+008$

$M_{u1+} = 4.6479E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$M_{u1-} = 7.8817E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 7.8817E+008$

$M_{u2+} = 4.6479E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

$M_{u2-} = 7.8817E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the 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:

$$u = 5.6369735E-005$$

$$\mu = 4.6479E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_o(5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.0053097$$

$$\phi_{we} \text{ (5.4c)} = 0.00204688$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\phi_{psh,min} * F_{ywe} = \text{Min}(\phi_{psh,x} * F_{ywe}, \phi_{psh,y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $\phi_{psh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{psh,x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 2.45559$$

$$\phi_{psh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{psh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{psh,y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 1.38519$$

$$\phi_{psh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{psh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 872.4558$$

$$fy_1 = 727.0465$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_0/l_{0u,min} = l_b/l_d = 1.00$$

$$s_u1 = 0.4 \cdot e_{su1,nominal} ((5.5), TBDY) = 0.032$$

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 $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } f_{s1} = (f_{s,jacket} \cdot A_{s,ten,jacket} + f_{s,core} \cdot A_{s,ten,core}) / A_{s,ten} = 727.0465$$

$$\text{with } E_{s1} = (E_{s,jacket} \cdot A_{s,ten,jacket} + E_{s,core} \cdot A_{s,ten,core}) / A_{s,ten} = 200000.00$$

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 882.7854$$

$$fy_2 = 735.6545$$

$$s_u2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_0/l_{0u,min} = l_b/l_{b,min} = 1.00$$

$$s_u2 = 0.4 \cdot e_{su2,nominal} ((5.5), TBDY) = 0.032$$

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 $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } f_{s2} = (f_{s,jacket} \cdot A_{s,com,jacket} + f_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 735.6545$$

$$\text{with } E_{s2} = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 200000.00$$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 937.50$$

$$fy_v = 781.25$$

$$s_{uv} = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_0/l_{0u,min} = l_b/l_d = 1.00$$

$$s_{uv} = 0.4 \cdot e_{suv,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{suv,nominal} = 0.08$,

considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
For calculation of $e_{suv,nominal}$ and y_v, sh_v, ft_v, 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.

$$\text{with } f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 781.25$$

$$\text{with } E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$$

$$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.06860752$$

$$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.12378842$$

$$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.04175429$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 30.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.08477074$$

$$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.15295169$$

$$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.05159117$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.09460844$$

$$\mu = M_{Rc} (4.14) = 4.6479E+008$$

$$u = s_u (4.1) = 5.6369735E-005$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Mu1-

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\mu = 6.0907698E-005$$

$$Mu = 7.8817E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$cc \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } cu = 0.0053097$$

$$we \text{ (5.4c)} = 0.00204688$$

$$ase \text{ ((5.4d), TBDY)} = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

$$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $psh_{min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.45559$$

$$ps1 \text{ (external)} = (Ash1 * h1 / s1) / A_{sec} = 0.00261799$$

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (Ash2 * h2 / s2) / A_{sec} = 0.00062519$$

$$Ash2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.38519$$

$$ps1 \text{ (external)} = (Ash1 * h1 / s1) / A_{sec} = 0.00156298$$

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 * h2 / s2) / A_{sec} = 0.00025008$$

$$Ash2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 781.25$$

$$fywe2 = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 882.7854$$

$fy1 = 735.6545$
 $su1 = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/ld = 1.00$
 $su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu1_nominal = 0.08$,
 For calculation of $esu1_nominal$ and $y1, sh1,ft1,fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 735.6545$
 with $Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$
 $y2 = 0.0025$
 $sh2 = 0.008$
 $ft2 = 872.4558$
 $fy2 = 727.0465$
 $su2 = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/lb,min = 1.00$
 $su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ and $y2, sh2,ft2,fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 727.0465$
 with $Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$
 $yv = 0.0025$
 $shv = 0.008$
 $ftv = 937.50$
 $fyv = 781.25$
 $suv = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/ld = 1.00$
 $suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv,ftv,fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 781.25$
 with $Es_v = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.12378842$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.06860752$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429$
 and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.15295169$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.08477074$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < vs,y2$ - LHS eq.(4.5) is not satisfied
 --->
 $v < vs,c$ - RHS eq.(4.5) is satisfied
 --->
 $su (4.8) = 0.16206515$

$$\begin{aligned} \mu &= M R_c (4.15) = 7.8817E+008 \\ u &= s_u (4.1) = 6.0907698E-005 \end{aligned}$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of μ_{2+}

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\begin{aligned} u &= 5.6369735E-005 \\ \mu &= 4.6479E+008 \end{aligned}$$

with full section properties:

$$\begin{aligned} b &= 400.00 \\ d &= 627.00 \\ d' &= 43.00 \\ v &= 0.000307 \\ N &= 2309.833 \\ f_c &= 30.00 \\ c_o (5A.5, TBDY) &= 0.002 \\ \text{Final value of } \mu: \mu^* &= \text{shear_factor} * \text{Max}(\mu_c, \mu_s) = 0.0053097 \\ \text{The Shear_factor is considered equal to 1 (pure moment strength)} \\ \text{From (5.4b), TBDY: } \mu_c &= 0.0053097 \\ \text{we (5.4c) } \mu_s &= 0.00204688 \\ \text{ase ((5.4d), TBDY) } &= (\text{ase}_1 * A_{ext} + \text{ase}_2 * A_{int}) / A_{sec} = 0.14776895 \\ \text{ase}_1 &= 0.14776895 \\ \text{bo}_1 &= 340.00 \\ \text{ho}_1 &= 610.00 \\ \text{bi}_2_1 &= 975400.00 \\ \text{ase}_2 &= \text{Max}(\text{ase}_1, \text{ase}_2) = 0.14776895 \\ \text{bo}_2 &= 192.00 \\ \text{ho}_2 &= 492.00 \\ \text{bi}_2_2 &= 557856.00 \end{aligned}$$

$\text{psh}_{min} * F_{ywe} = \text{Min}(\text{psh}_x * F_{ywe}, \text{psh}_y * F_{ywe}) = 1.38519$
Expression ((5.4d), TBDY) for $\text{psh}_{min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\begin{aligned} \text{psh}_x * F_{ywe} &= \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 2.45559 \\ \text{ps}_1 (\text{external}) &= (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799 \\ A_{sh1} &= A_{stir_1} * n_{s_1} = 157.0796 \\ \text{No stirrups, } n_{s_1} &= 2.00 \\ h_1 &= 670.00 \\ \text{ps}_2 (\text{internal}) &= (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519 \\ A_{sh2} &= A_{stir_2} * n_{s_2} = 100.531 \\ \text{No stirrups, } n_{s_2} &= 2.00 \\ h_2 &= 500.00 \end{aligned}$$

$$\begin{aligned} \text{psh}_y * F_{ywe} &= \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 1.38519 \\ \text{ps}_1 (\text{external}) &= (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298 \\ A_{sh1} &= A_{stir_1} * n_{s_1} = 157.0796 \\ \text{No stirrups, } n_{s_1} &= 2.00 \\ h_1 &= 400.00 \\ \text{ps}_2 (\text{internal}) &= (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008 \\ A_{sh2} &= A_{stir_2} * n_{s_2} = 100.531 \\ \text{No stirrups, } n_{s_2} &= 2.00 \\ h_2 &= 200.00 \end{aligned}$$

$$\begin{aligned} A_{sec} &= 268000.00 \\ s_1 &= 150.00 \\ s_2 &= 300.00 \\ f_{ywe1} &= 781.25 \end{aligned}$$

$$fy_{w2} = 656.25$$

$$f_{ce} = 30.00$$

From (5A.5), TBDY, TBDY: $cc = 0.002$

$c =$ confinement factor = 1.00

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 872.4558$$

$$fy_1 = 727.0465$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, min = lb/ld = 1.00$$

$$su_1 = 0.4 * esu_{1, nominal} ((5.5), TBDY) = 0.032$$

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 $fs_1 = (fs_{jacket} * A_{sl, ten, jacket} + fs_{core} * A_{sl, ten, core}) / A_{sl, ten} = 727.0465$

with $Es_1 = (Es_{jacket} * A_{sl, ten, jacket} + Es_{core} * A_{sl, ten, core}) / A_{sl, ten} = 200000.00$

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 882.7854$$

$$fy_2 = 735.6545$$

$$su_2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, min = lb/lb, min = 1.00$$

$$su_2 = 0.4 * esu_{2, nominal} ((5.5), TBDY) = 0.032$$

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 $fs_2 = (fs_{jacket} * A_{sl, com, jacket} + fs_{core} * A_{sl, com, core}) / A_{sl, com} = 735.6545$

with $Es_2 = (Es_{jacket} * A_{sl, com, jacket} + Es_{core} * A_{sl, com, core}) / A_{sl, com} = 200000.00$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 937.50$$

$$fy_v = 781.25$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, min = lb/ld = 1.00$$

$$suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fsv = (fs_{jacket} * A_{sl, mid, jacket} + fs_{mid} * A_{sl, mid, core}) / A_{sl, mid} = 781.25$

with $Es_v = (Es_{jacket} * A_{sl, mid, jacket} + Es_{mid} * A_{sl, mid, core}) / A_{sl, mid} = 200000.00$

$$1 = A_{sl, ten} / (b * d) * (fs_1 / f_c) = 0.06860752$$

$$2 = A_{sl, com} / (b * d) * (fs_2 / f_c) = 0.12378842$$

$$v = A_{sl, mid} / (b * d) * (fsv / f_c) = 0.04175429$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 30.00$$

$$cc (5A.5, TBDY) = 0.002$$

$c =$ confinement factor = 1.00

$$1 = A_{sl, ten} / (b * d) * (fs_1 / f_c) = 0.08477074$$

$$2 = A_{sl, com} / (b * d) * (fs_2 / f_c) = 0.15295169$$

$$v = A_{sl, mid} / (b * d) * (fsv / f_c) = 0.05159117$$

Case/Assumption: Unconfined full section - Steel rupture

satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.09460844$$

$$M_u = M_{Rc} (4.14) = 4.6479E+008$$

$$u = s_u (4.1) = 5.6369735E-005$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of M_{u2} -

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 6.0907698E-005$$

$$M_u = 7.8817E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_o (5A.5, TBDY) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.0053097$$

$$\phi_{we} (5.4c) = 0.00204688$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.45559$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh,y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.38519$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 781.25

fywe2 = 656.25

fce = 30.00

From ((5.A.5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 882.7854

fy1 = 735.6545

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fsjacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 735.6545

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025

sh2 = 0.008

ft2 = 872.4558

fy2 = 727.0465

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 727.0465

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 937.50

fyv = 781.25

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered

characteristic value fsy = 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 = 781.25

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.12378842

2 = Asl,com/(b*d)*(fs2/fc) = 0.06860752

v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 30.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00
1 = $As_{l,ten}/(b*d)*(f_s1/f_c) = 0.15295169$
2 = $As_{l,com}/(b*d)*(f_s2/f_c) = 0.08477074$
v = $As_{l,mid}/(b*d)*(f_{sv}/f_c) = 0.05159117$

Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

---->
v < $v_{s,y2}$ - LHS eq.(4.5) is not satisfied

---->
v < $v_{s,c}$ - RHS eq.(4.5) is satisfied

---->
su (4.8) = 0.16206515
Mu = MRc (4.15) = 7.8817E+008
u = su (4.1) = 6.0907698E-005

Calculation of ratio lb/l_d

Adequate Lap Length: lb/l_d >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 578810.994

Calculation of Shear Strength at edge 1, Vr1 = 578810.994
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 = 192813.976
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c,jacket}*Area_{jacket} + f'_{c,core}*Area_{core})/Area_{section} = 27.76119$, but $f_c^{0.5} < =$
8.3 MPa (22.5.3.1, ACI 318-14)
pw = $As/(b_w*d) = 0.00331157$
As (tension reinf.) = 709.9999
bw = 400.00
d = 536.00
 $V_u*d/M_u < 1 = 1.00$
Mu = 1.1510E+006
Vu = 9840.634

From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 385997.017
Vs1 = 350811.18 is calculated for jacket, with:

d = 536.00
Av = 157079.633
fy = 625.00
s = 150.00

Vs1 has been multiplied by 1 (s < d/2, according to ASCE 41-17,10.3.4)

Vs2 = 35185.838 is calculated for jacket, with:

d2 = 400.00
Av = 100530.965
fy = 525.00
s = 300.00

Vs2 has been multiplied by 2(1-s/d) (s > d/2, according to ASCE 41-17,10.3.4)

2(1-s/d) = 0.50

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: Vs + Vf <= 750430.726

Calculation of Shear Strength at edge 2, Vr2 = 578810.994
Vr2 = Vn ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: Vc = 192813.976
= 1 (normal-weight concrete)

Mean concrete strength: $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 27.76119$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$$p_w = A_s / (b_w \cdot d) = 0.00331157$$

$$A_s (\text{tension reinf.}) = 709.9999$$

$$b_w = 400.00$$

$$d = 536.00$$

$$V_u \cdot d / \mu_u < 1 = 1.00$$

$$\mu_u = 1.1510E+006$$

$$V_u = 9840.632$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 385997.017$

$V_{s1} = 350811.18$ is calculated for jacket, with:

$$d = 536.00$$

$$A_v = 157079.633$$

$$f_y = 625.00$$

$$s = 150.00$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 35185.838$ is calculated for jacket, with:

$$d = 400.00$$

$$A_v = 100530.965$$

$$f_y = 525.00$$

$$s = 300.00$$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$$V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$$

$$\text{From (11-11), ACI } 440: V_s + V_f \leq 750430.726$$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 0.87$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 656.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_o/l_{ou}, \min >= 1$)
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = -9.0372119E-015$
EDGE -B-
Shear Force, $V_b = 9.0372119E-015$
BOTH EDGES
Axial Force, $F = -2309.833$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 709.9999$
-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 , $V_e/V_r = 0.55914272$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u * l_n / 2 = 218168.257$
with
 $M_{pr1} = \text{Max}(Mu_{1+} , Mu_{1-}) = 3.2725E+008$
 $Mu_{1+} = 3.2725E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
 $Mu_{1-} = 3.2725E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(Mu_{2+} , Mu_{2-}) = 3.2725E+008$
 $Mu_{2+} = 3.2725E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
 $Mu_{2-} = 3.2725E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination
and
 $\pm w_u * l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = -9.0372119E-015$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 9.0372119E-015$, is the shear force acting at edge 2 for the the static loading combination

Calculation of Mu_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 0.00010507$
 $M_u = 3.2725E+008$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.0003219$
 $N = 2309.833$
 $f_c = 30.00$
 ϕ_o (5A.5, TBDY) = 0.002
Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0053097$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $c_u = 0.0053097$

w_e (5.4c) = 0.00204688

a_{se} ((5.4d), TBDY) = $(a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o,1} = 340.00$

$h_{o,1} = 610.00$

$b_{i2,1} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o,2} = 192.00$

$h_{o,2} = 492.00$

$b_{i2,2} = 557856.00$

$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.38519$

Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.45559$

p_{s1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir,1} * n_{s,1} = 157.0796$

No stirrups, $n_{s,1} = 2.00$

$h_1 = 670.00$

p_{s2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$

$A_{sh2} = A_{stir,2} * n_{s,2} = 100.531$

No stirrups, $n_{s,2} = 2.00$

$h_2 = 500.00$

 $p_{sh,y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.38519$

p_{s1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$

$A_{sh1} = A_{stir,1} * n_{s,1} = 157.0796$

No stirrups, $n_{s,1} = 2.00$

$h_1 = 400.00$

p_{s2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$

$A_{sh2} = A_{stir,2} * n_{s,2} = 100.531$

No stirrups, $n_{s,2} = 2.00$

$h_2 = 200.00$

 $A_{sec} = 268000.00$

$s_1 = 150.00$

$s_2 = 300.00$

$f_{ywe1} = 781.25$

$f_{ywe2} = 656.25$

$f_{ce} = 30.00$

From ((5.A5), TBDY), TBDY: $c_c = 0.002$

c = confinement factor = 1.00

$y_1 = 0.0025$

$sh_1 = 0.008$

$ft_1 = 886.8103$

$fy_1 = 739.0086$

$su_1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$l_o / l_{ou, \min} = l_b / l_d = 1.00$

$su_1 = 0.4 * esu_{1, \text{nominal}}$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esu_{1, \text{nominal}} = 0.08$,

For calculation of $esu_{1, \text{nominal}}$ and y_1, sh_1, ft_1, fy_1 , it is considered
characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 739.0086$

with $Es_1 = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$

$y_2 = 0.0025$

$sh_2 = 0.008$

$ft_2 = 886.8103$

$fy_2 = 739.0086$

$su_2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 895.9746

fyv = 746.6455

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814

2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814

v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 30.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192

2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192

v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

v < vs,c - RHS eq.(4.5) is satisfied

--->

su (4.9) = 0.1468828

Mu = MRc (4.14) = 3.2725E+008

u = su (4.1) = 0.00010507

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 0.00010507

Mu = 3.2725E+008

with full section properties:

b = 670.00

d = 357.00

d' = 43.00

$$v = 0.0003219$$

$$N = 2309.833$$

$$fc = 30.00$$

$$co (5A.5, TBDY) = 0.002$$

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } cu = 0.0053097$$

$$\text{we (5.4c) = } 0.00204688$$

$$\text{ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = } 0.14776895$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

$$ase2 = \text{Max}(ase1,ase2) = 0.14776895$$

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

$$psh,\text{min}*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.38519$$

Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.45559$$

$$ps1 \text{ (external) = (Ash1*h1/s1)/Asec = } 0.00261799$$

$$Ash1 = \text{Astir}_1*ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal) = (Ash2*h2/s2)/Asec = } 0.00062519$$

$$Ash2 = \text{Astir}_2*ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.38519$$

$$ps1 \text{ (external) = (Ash1*h1/s1)/Asec = } 0.00156298$$

$$Ash1 = \text{Astir}_1*ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal) = (Ash2*h2/s2)/Asec = } 0.00025008$$

$$Ash2 = \text{Astir}_2*ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 781.25$$

$$fywe2 = 656.25$$

$$fce = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 886.8103$$

$$fy1 = 739.0086$$

$$su1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$lo/lou,\text{min} = lb/ld = 1.00$$

$$su1 = 0.4*esu1_nominal \text{ ((5.5), TBDY) = } 0.032$$

$$\text{From table 5A.1, TBDY: } esu1_nominal = 0.08,$$

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

$$y1, sh1,ft1,fy1, \text{ are also multiplied by } \text{Min}(1,1.25*(lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs1 = (fs,\text{jacket}*Asl,\text{ten,jacket} + fs,\text{core}*Asl,\text{ten,core})/Asl,\text{ten} = 739.0086$$

$$\text{with } Es1 = (Es,\text{jacket}*Asl,\text{ten,jacket} + Es,\text{core}*Asl,\text{ten,core})/Asl,\text{ten} = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 886.8103$$

$$fy2 = 739.0086$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou,min = lb/lb,min = 1.00$$

$$su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086$$

$$\text{with } Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 895.9746$$

$$fyv = 746.6455$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou,min = lb/ld = 1.00$$

$$suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455$$

$$\text{with } Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$$

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814$$

$$2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814$$

$$v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 30.00$$

$$cc (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192$$

$$2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192$$

$$v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

$v < vs,c$ - RHS eq.(4.5) is satisfied

---->

$$su (4.9) = 0.1468828$$

$$Mu = MRc (4.14) = 3.2725E+008$$

$$u = su (4.1) = 0.00010507$$

Calculation of ratio lb/ld

Adequate Lap Length: $lb/ld \geq 1$

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 0.00010507$$

$$Mu = 3.2725E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.0053097$$

$$w_e \text{ (5.4c)} = 0.00204688$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.45559$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.38519$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 886.8103$$

$$fy_1 = 739.0086$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o / l_{ou, \min} = l_b / l_d = 1.00$$

$$su_1 = 0.4 * esu_{1, \text{nominal}} \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu_{1, \text{nominal}} = 0.08,$$

For calculation of $esu_{1, \text{nominal}}$ and y_1, sh_1, ft_1, fy_1 , it is considered characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_1 = (fs_{jacket} \cdot A_{sl,ten,jacket} + fs_{core} \cdot A_{sl,ten,core}) / A_{sl,ten} = 739.0086$

with $Es_1 = (Es_{jacket} \cdot A_{sl,ten,jacket} + Es_{core} \cdot A_{sl,ten,core}) / A_{sl,ten} = 200000.00$

$y_2 = 0.0025$

$sh_2 = 0.008$

$ft_2 = 886.8103$

$fy_2 = 739.0086$

$su_2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$lo/lo_{u,min} = lb/lb_{min} = 1.00$

$su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,

For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_2 = (fs_{jacket} \cdot A_{sl,com,jacket} + fs_{core} \cdot A_{sl,com,core}) / A_{sl,com} = 739.0086$

with $Es_2 = (Es_{jacket} \cdot A_{sl,com,jacket} + Es_{core} \cdot A_{sl,com,core}) / A_{sl,com} = 200000.00$

$y_v = 0.0025$

$sh_v = 0.008$

$ft_v = 895.9746$

$fy_v = 746.6455$

$su_v = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$lo/lo_{u,min} = lb/ld = 1.00$

$su_v = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,

considering characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY

For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_v = (fs_{jacket} \cdot A_{sl,mid,jacket} + fs_{mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 746.6455$

with $Es_v = (Es_{jacket} \cdot A_{sl,mid,jacket} + Es_{mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 200000.00$

$1 = A_{sl,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.09382814$

$2 = A_{sl,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.09382814$

$v = A_{sl,mid} / (b \cdot d) \cdot (fs_v / fc) = 0.05785932$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

$f_{cc} (5A.2, TBDY) = 30.00$

$cc (5A.5, TBDY) = 0.002$

$c = \text{confinement factor} = 1.00$

$1 = A_{sl,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.11251192$

$2 = A_{sl,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.11251192$

$v = A_{sl,mid} / (b \cdot d) \cdot (fs_v / fc) = 0.06938071$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

---->

$su (4.9) = 0.1468828$

$Mu = MRc (4.14) = 3.2725E+008$

$u = su (4.1) = 0.00010507$

Calculation of ratio lb/ld

Adequate Lap Length: $lb/ld \geq 1$

Calculation of Mu_2 -

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 0.00010507$$
$$\mu = 3.2725E+008$$

with full section properties:

$$b = 670.00$$
$$d = 357.00$$
$$d' = 43.00$$
$$v = 0.0003219$$
$$N = 2309.833$$
$$f_c = 30.00$$
$$c_o(5A.5, \text{TBDY}) = 0.002$$

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0053097$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\phi_u = 0.0053097$
we (5.4c) = 0.00204688
ase ((5.4d), TBDY) = $(\text{ase}_1 * A_{\text{ext}} + \text{ase}_2 * A_{\text{int}}) / A_{\text{sec}} = 0.14776895$
 $\text{ase}_1 = 0.14776895$
 $\text{bo}_1 = 340.00$
 $\text{ho}_1 = 610.00$
 $\text{bi}_2_1 = 975400.00$
 $\text{ase}_2 = \text{Max}(\text{ase}_1, \text{ase}_2) = 0.14776895$
 $\text{bo}_2 = 192.00$
 $\text{ho}_2 = 492.00$
 $\text{bi}_2_2 = 557856.00$
 $\text{psh}_{\text{min}} * F_{ywe} = \text{Min}(\text{psh}_x * F_{ywe}, \text{psh}_y * F_{ywe}) = 1.38519$
Expression ((5.4d), TBDY) for $\text{psh}_{\text{min}} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\text{psh}_x * F_{ywe} = \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 2.45559$$
$$\text{ps}_1 (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{\text{sec}} = 0.00261799$$
$$A_{sh1} = A_{\text{stir}_1} * n_{s1} = 157.0796$$
$$\text{No stirrups, } n_{s1} = 2.00$$
$$h_1 = 670.00$$
$$\text{ps}_2 (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{\text{sec}} = 0.00062519$$
$$A_{sh2} = A_{\text{stir}_2} * n_{s2} = 100.531$$
$$\text{No stirrups, } n_{s2} = 2.00$$
$$h_2 = 500.00$$

$$\text{psh}_y * F_{ywe} = \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 1.38519$$
$$\text{ps}_1 (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{\text{sec}} = 0.00156298$$
$$A_{sh1} = A_{\text{stir}_1} * n_{s1} = 157.0796$$
$$\text{No stirrups, } n_{s1} = 2.00$$
$$h_1 = 400.00$$
$$\text{ps}_2 (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{\text{sec}} = 0.00025008$$
$$A_{sh2} = A_{\text{stir}_2} * n_{s2} = 100.531$$
$$\text{No stirrups, } n_{s2} = 2.00$$
$$h_2 = 200.00$$

$$A_{\text{sec}} = 268000.00$$
$$s_1 = 150.00$$
$$s_2 = 300.00$$
$$f_{ywe1} = 781.25$$
$$f_{ywe2} = 656.25$$
$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.002$$
$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$
$$sh_1 = 0.008$$
$$ft_1 = 886.8103$$
$$fy_1 = 739.0086$$
$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_0/l_{ou,min} = l_b/l_d = 1.00$$

$$s_u1 = 0.4 * e_{su1,nominal} ((5.5), TBDY) = 0.032$$

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.

$$\text{with } f_{s1} = (f_{s,jacket} * A_{s,ten,jacket} + f_{s,core} * A_{s,ten,core}) / A_{s,ten} = 739.0086$$

$$\text{with } E_{s1} = (E_{s,jacket} * A_{s,ten,jacket} + E_{s,core} * A_{s,ten,core}) / A_{s,ten} = 200000.00$$

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 886.8103$$

$$fy_2 = 739.0086$$

$$s_u2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$$l_0/l_{ou,min} = l_b/l_{b,min} = 1.00$$

$$s_u2 = 0.4 * e_{su2,nominal} ((5.5), TBDY) = 0.032$$

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.

$$\text{with } f_{s2} = (f_{s,jacket} * A_{s,com,jacket} + f_{s,core} * A_{s,com,core}) / A_{s,com} = 739.0086$$

$$\text{with } E_{s2} = (E_{s,jacket} * A_{s,com,jacket} + E_{s,core} * A_{s,com,core}) / A_{s,com} = 200000.00$$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 895.9746$$

$$fy_v = 746.6455$$

$$s_{uv} = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$$l_0/l_{ou,min} = l_b/l_d = 1.00$$

$$s_{uv} = 0.4 * e_{suv,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{suv,nominal} = 0.08$,

considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY

For calculation of $e_{suv,nominal}$ and y_v, sh_v, ft_v, 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.

$$\text{with } f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 746.6455$$

$$\text{with } E_{sv} = (E_{s,jacket} * A_{s,mid,jacket} + E_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 200000.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.09382814$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.09382814$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.05785932$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 30.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.11251192$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.11251192$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.06938071$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.1468828$$

$$\mu_u = M_{Rc} (4.14) = 3.2725E+008$$

$$u = s_u (4.1) = 0.00010507$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 390183.487$

Calculation of Shear Strength at edge 1, $V_{r1} = 390183.487$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 27.76119$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $p_w = A_s / (b_w \cdot d) = 0.00331157$
As (tension reinf.) = 709.9999
bw = 670.00
d = 320.00
 $V_u \cdot d / \mu < 1 = 0.00$
 $\mu = 6.8565666E-012$
 $V_u = 9.0372119E-015$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
d = 320.00
 $A_v = 157079.633$
fy = 625.00
s = 150.00
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:
d2 = 160.00
 $A_v = 100530.965$
fy = 525.00
s = 300.00
 V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

Calculation of Shear Strength at edge 2, $V_{r2} = 390183.487$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 27.76119$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $p_w = A_s / (b_w \cdot d) = 0.00331157$
As (tension reinf.) = 709.9999
bw = 670.00
d = 320.00
 $V_u \cdot d / \mu < 1 = 0.00$
 $\mu = 2.0256286E-011$
 $V_u = 9.0372119E-015$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
d = 320.00
 $A_v = 157079.633$
fy = 625.00
s = 150.00
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:
d = 160.00
 $A_v = 100530.965$
fy = 525.00

s = 300.00

Vs2 is considered 0 (s>d, according to ASCE 41-17,10.3.4)

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: Vs + Vf <= 750430.726

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 0.87$

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_b/d \geq 1$)

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 9.0425E+006$

Shear Force, $V_2 = 2.4489115E-014$

Shear Force, $V_3 = 1166.41$

Axial Force, $F = -9608.729$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 709.9999$

-Compression: $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 709.9999$

-Compression: $As_{c,com} = 1266.062$

-Middle: $As_{mid} = 402.1239$

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten,jacket} = 402.1239$

-Compression: $As_{c,com,jacket} = 804.2477$

-Middle: $As_{mid,jacket} = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten,core} = 307.8761$

-Compression: $As_{c,com,core} = 461.8141$

-Middle: $Asl_{mid,core} = 0.00$

Mean Diameter of Tension Reinforcement, $DbL = 15.00$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_{R} = u = 0.02848337$
 $u = y + p = 0.0327395$

- Calculation of y -

$y = (My * Ls / 3) / E_{eff} = 0.0077395$ ((4.29), Biskinis Phd))
 $My = 2.9297E+008$
 $Ls = M/V$ (with $Ls > 0.1 * L$ and $Ls < 2 * L$) = 6000.00
From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 7.5708E+013$

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 5.8262953E-006$
with $f_y = 625.00$
 $d = 627.00$
 $y = 0.18885675$
 $A = 0.00954705$
 $B = 0.00409845$
with $pt = 0.00283094$
 $pc = 0.00504809$
 $pv = 0.00160336$
 $N = 9608.729$
 $b = 400.00$
 $" = 0.06858054$
 $y_{comp} = 1.7813453E-005$
with $f_c = 27.76119$
 $E_c = 25742.96$
 $y = 0.18781039$
 $A = 0.00939108$
 $B = 0.0040338$
with $E_s = 200000.00$

Calculation of ratio lb/d

Adequate Lap Length: $lb/d \geq 1$

- Calculation of p -

From table 10-7: $p = 0.025$

with:

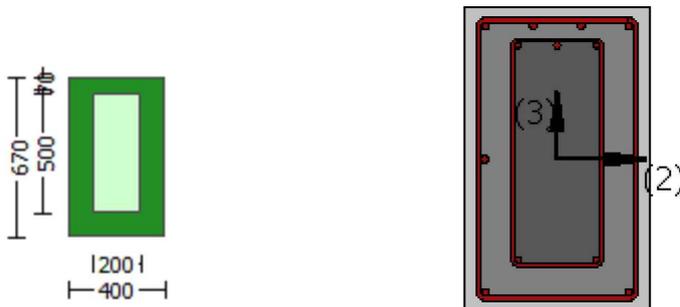
- Condition i occurred
Beam controlled by flexure: $V_p/V_o \leq 1$
shear control ratio $V_p/V_o = 0.92480584$
- Transverse Reinforcement: C
- Stirrup Spacing $\leq d/3$
- Low ductility demand, $\gamma / y < 2$ (table 10-6, ASCE 41-17)
 $= 7.8771085E-005$
- Stirrup Spacing $\leq d/2$
 $d = d_{external} = 627.00$
 $s = s_{external} = 150.00$
- Strength provided by hoops $V_s < 3/4 * \text{design Shear}$
 $V_s = 421182.855$, already given in calculation of shear control ratio
design Shear = 1166.41

$\rho = A_{st}/(b_w*d) = 0.00283094$
 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: $\rho_{bal} = 0.01202003$
 $f_c = (f_{c_jacket}*Area_jacket + f_{c_core}*Area_core)/section_area = 27.76119$
 $f_y = f_{y_jacket_bars} = 625.00$
 From 10.2.7.3, ACI 318-11: $\beta_1 = 0.65$
 From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + \rho) = 0.48979592$
 $\rho_y = 0.003125$
 $V/(b_w*d*f_c^{0.5}) = 0.01062987$, NOTE: units in lb & in
 $b_w = 400.00$

 End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1
 At local axis: 2
 Integration Section: (a)

Calculation No. 11

beam B1, Floor 1
 Limit State: Life Safety (data interpolation between analysis steps 1 and 2)
 Analysis: Uniform +X
 Check: Shear capacity 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, $\phi = 0.87$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 420.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{o,u,min} = l_b/l_d \geq 1$)

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 9.0425E+006$

Shear Force, $V_a = 1166.41$

EDGE -B-

Bending Moment, $M_b = 1.6981E+007$

Shear Force, $V_b = 18514.856$

BOTH EDGES

Axial Force, $F = -9608.729$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{s,t} = 709.9999$

-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, $Db_{L,ten} = 15.00$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = V_n = 397771.806$

V_n ((22.5.1.1), ACI 318-14) = 457208.973

NOTE: In expression (22.5.1.1) '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: $V_c = 148411.359$

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_c_jacket * Area_jacket + f'_c_core * Area_core) / Area_section = 18.50746$, but $f_c^{0.5} < = 8.3$ MPa (22.5.3.1, ACI 318-14)

$p_w = A_s / (b_w * d) = 0.00331157$

A_s (tension reinf.) = 709.9999

$b_w = 400.00$

$d = 536.00$

$V_u * d / M_u < 1 = 0.06913998$

$M_u = 9.0425E+006$

$V_u = 1166.41$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 308797.614$

$V_{s1} = 280648.944$ is calculated for jacket, with:

$d = 536.00$

$A_v = 157079.633$

$f_y = 500.00$

$s = 150.00$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 28148.67$ is calculated for core, with:

$d = 400.00$

$A_v = 100530.965$

$f_y = 420.00$

$s = 300.00$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

V_f ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 612724.122$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 12

beam B1, Floor 1

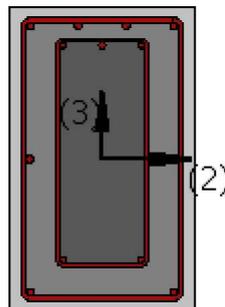
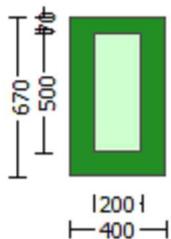
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (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, $\phi = 0.87$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 656.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou, \min} \geq 1$)

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 9840.634$

EDGE -B-

Shear Force, $V_b = 9840.632$

BOTH EDGES

Axial Force, $F = -2309.833$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{sl,t} = 709.9999$

-Compression: $A_{sl,c} = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten} = 709.9999$

-Compression: $A_{sl,com} = 1266.062$

-Middle: $A_{sl,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.92480584$

Member Controlled by Flexure ($V_e/V_r < 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 535287.788$

with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 7.8817E+008$

$M_{u1+} = 4.6479E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$M_{u1-} = 7.8817E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 7.8817E+008$

$\mu_{2+} = 4.6479E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

$\mu_{2-} = 7.8817E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination
and

$$\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$$

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 μ according to 4.1, Biskinis/Fardis 2013:

$$\mu = 5.6369735E-005$$

$$\mu = 4.6479E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} \cdot \text{Max}(\mu, c_c) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu = 0.0053097$$

$$w_e \text{ (5.4c)} = 0.00204688$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} \cdot F_{ywe} = \text{Min}(p_{sh, x} \cdot F_{ywe}, p_{sh, y} \cdot F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $p_{sh, \min} \cdot F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh, x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{sh2} \cdot F_{ywe2} = 2.45559$$

$$p_{s1} \text{ (external)} = (A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} \cdot n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{sh2} \cdot F_{ywe2} = 1.38519$$

$$p_{s1} \text{ (external)} = (A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} \cdot n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$fy_{we1} = 781.25$$

$$fy_{we2} = 656.25$$

$$f_{ce} = 30.00$$

From ((5.A.5), TBDY), TBDY: $cc = 0.002$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 872.4558$$

$$fy_1 = 727.0465$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$su_1 = 0.4 * esu_{1, \text{nominal}} ((5.5), \text{TBDY}) = 0.032$$

From table 5A.1, TBDY: $esu_{1, \text{nominal}} = 0.08$,

For calculation of $esu_{1, \text{nominal}}$ and y_1, sh_1, ft_1, fy_1 , it is considered
characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_1 = (fs_{\text{jacket}} * Asl, \text{ten, jacket} + fs_{\text{core}} * Asl, \text{ten, core}) / Asl, \text{ten} = 727.0465$$

$$\text{with } Es_1 = (Es_{\text{jacket}} * Asl, \text{ten, jacket} + Es_{\text{core}} * Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 882.7854$$

$$fy_2 = 735.6545$$

$$su_2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 1.00$$

$$su_2 = 0.4 * esu_{2, \text{nominal}} ((5.5), \text{TBDY}) = 0.032$$

From table 5A.1, TBDY: $esu_{2, \text{nominal}} = 0.08$,

For calculation of $esu_{2, \text{nominal}}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_2 = (fs_{\text{jacket}} * Asl, \text{com, jacket} + fs_{\text{core}} * Asl, \text{com, core}) / Asl, \text{com} = 735.6545$$

$$\text{with } Es_2 = (Es_{\text{jacket}} * Asl, \text{com, jacket} + Es_{\text{core}} * Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 937.50$$

$$fy_v = 781.25$$

$$su_v = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$su_v = 0.4 * esu_{v, \text{nominal}} ((5.5), \text{TBDY}) = 0.032$$

From table 5A.1, TBDY: $esu_{v, \text{nominal}} = 0.08$,

considering characteristic value $fsy_v = fs_v/1.2$, from table 5.1, TBDY

For calculation of $esu_{v, \text{nominal}}$ and y_v, sh_v, ft_v, fy_v , it is considered
characteristic value $fsy_v = fs_v/1.2$, from table 5.1, 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.

$$\text{with } fs_v = (fs_{\text{jacket}} * Asl, \text{mid, jacket} + fs_{\text{mid}} * Asl, \text{mid, core}) / Asl, \text{mid} = 781.25$$

$$\text{with } Es_v = (Es_{\text{jacket}} * Asl, \text{mid, jacket} + Es_{\text{mid}} * Asl, \text{mid, core}) / Asl, \text{mid} = 200000.00$$

$$1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.06860752$$

$$2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.12378842$$

$$v = Asl, \text{mid} / (b * d) * (fs_v / f_c) = 0.04175429$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, \text{TBDY}) = 30.00$$

$$cc (5A.5, \text{TBDY}) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.08477074$$

$$2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.15295169$$

$$v = Asl, \text{mid} / (b * d) * (fs_v / f_c) = 0.05159117$$

Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

--->
v < vs,y2 - LHS eq.(4.5) is satisfied

--->
su (4.9) = 0.09460844
Mu = MRc (4.14) = 4.6479E+008
u = su (4.1) = 5.6369735E-005

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 6.0907698E-005
Mu = 7.8817E+008

with full section properties:

b = 400.00
d = 627.00
d' = 43.00
v = 0.000307
N = 2309.833
fc = 30.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0053097
The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.0053097
we (5.4c) = 0.00204688
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.38519
Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.45559
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.38519
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 781.25

fywe2 = 656.25

fce = 30.00

From ((5.A.5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 882.7854

fy1 = 735.6545

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 735.6545

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025

sh2 = 0.008

ft2 = 872.4558

fy2 = 727.0465

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 727.0465

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 937.50

fyv = 781.25

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 781.25

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.12378842

2 = Asl,com/(b*d)*(fs2/fc) = 0.06860752

v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 30.00

$$cc \text{ (5A.5, TBDY)} = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.15295169$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.08477074$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05159117$$

Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is not satisfied

--->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied

$$su \text{ (4.8)} = 0.16206515$$

$$Mu = MRc \text{ (4.15)} = 7.8817E+008$$

$$u = su \text{ (4.1)} = 6.0907698E-005$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Mu_{2+}

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 5.6369735E-005$$

$$Mu = 4.6479E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$co \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } cu = 0.0053097$$

$$we \text{ (5.4c)} = 0.00204688$$

$$ase \text{ ((5.4d), TBDY)} = (ase1*A_{ext} + ase2*A_{int})/A_{sec} = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

$$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $psh_{min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.45559$$

$$ps1 \text{ (external)} = (A_{sh1} * h1 / s1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (A_{sh2} * h2 / s2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.38519$$

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$$

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$$

$$Ash2 = Astir_2 \cdot ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 781.25$$

$$fywe2 = 656.25$$

$$fce = 30.00$$

$$\text{From } ((5.A.5), \text{ TBDY}), \text{ TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 872.4558$$

$$fy1 = 727.0465$$

$$su1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \text{min} = lb/ld = 1.00$$

$$su1 = 0.4 \cdot esu1_{\text{nominal}} ((5.5), \text{ TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu1_{\text{nominal}} = 0.08,$$

For calculation of $esu1_{\text{nominal}}$ and $y1, sh1, ft1, fy1$, it is considered
characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs1 = (fs_{\text{jacket}} \cdot Asl, \text{ten, jacket} + fs_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 727.0465$$

$$\text{with } Es1 = (Es_{\text{jacket}} \cdot Asl, \text{ten, jacket} + Es_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 882.7854$$

$$fy2 = 735.6545$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \text{min} = lb/lb, \text{min} = 1.00$$

$$su2 = 0.4 \cdot esu2_{\text{nominal}} ((5.5), \text{ TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu2_{\text{nominal}} = 0.08,$$

For calculation of $esu2_{\text{nominal}}$ and $y2, sh2, ft2, fy2$, it is considered
characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs2 = (fs_{\text{jacket}} \cdot Asl, \text{com, jacket} + fs_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 735.6545$$

$$\text{with } Es2 = (Es_{\text{jacket}} \cdot Asl, \text{com, jacket} + Es_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 937.50$$

$$fyv = 781.25$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \text{min} = lb/ld = 1.00$$

$$suv = 0.4 \cdot esuv_{\text{nominal}} ((5.5), \text{ TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esuv_{\text{nominal}} = 0.08,$$

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_{\text{nominal}}$ and yv, shv, ftv, fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fsv = (fs_{\text{jacket}} \cdot Asl, \text{mid, jacket} + fs_{\text{mid}} \cdot Asl, \text{mid, core}) / Asl, \text{mid} = 781.25$$

$$\text{with } Esv = (Es_{\text{jacket}} \cdot Asl, \text{mid, jacket} + Es_{\text{mid}} \cdot Asl, \text{mid, core}) / Asl, \text{mid} = 200000.00$$

$$1 = Asl, \text{ten} / (b \cdot d) \cdot (fs1 / fce) = 0.06860752$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.12378842$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.04175429$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 30.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.08477074$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.15295169$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05159117$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.09460844$$

$$M_u = M_{Rc} (4.14) = 4.6479E+008$$

$$u = s_u (4.1) = 5.6369735E-005$$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of M_{u2} -

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 6.0907698E-005$$

$$M_u = 7.8817E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.0053097$$

$$w_e (5.4c) = 0.00204688$$

$$a_{se} ((5.4d), TBDY) = (a_{se1}*A_{ext} + a_{se2}*A_{int})/A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh,min}*F_{ywe} = \text{Min}(p_{sh,x}*F_{ywe}, p_{sh,y}*F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $p_{sh,min}*F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh_x}*F_{ywe} = p_{sh1}*F_{ywe1} + p_{sh2}*F_{ywe2} = 2.45559$$

$$p_{s1} (\text{external}) = (A_{sh1}*h_1/s_1)/A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1}*n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} (\text{internal}) = (A_{sh2}*h_2/s_2)/A_{sec} = 0.00062519$$

Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.38519
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 781.25

fywe2 = 656.25

fce = 30.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 882.7854

fy1 = 735.6545

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 735.6545

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025

sh2 = 0.008

ft2 = 872.4558

fy2 = 727.0465

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 727.0465

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 937.50

fyv = 781.25

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered

characteristic value $f_{sv} = f_{sv}/1.2$, 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 $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 781.25$

with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.12378842$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.06860752$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.04175429$

and confined core properties:

$b = 340.00$

$d = 597.00$

$d' = 13.00$

$f_{cc} (5A.2, TBDY) = 30.00$

$cc (5A.5, TBDY) = 0.002$

$c = \text{confinement factor} = 1.00$

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.15295169$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.08477074$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.05159117$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

$v < v_{s,y2}$ - LHS eq.(4.5) is not satisfied

---->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

---->

$su (4.8) = 0.16206515$

$Mu = MRc (4.15) = 7.8817E+008$

$u = su (4.1) = 6.0907698E-005$

Calculation of ratio lb/ld

Adequate Lap Length: $lb/ld \geq 1$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 578810.994$

Calculation of Shear Strength at edge 1, $V_{r1} = 578810.994$

$V_{r1} = V_n ((22.5.1.1), ACI 318-14)$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 192813.976$

$= 1$ (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_{c,jacket} \cdot Area_{jacket} + f'_{c,core} \cdot Area_{core}) / Area_{section} = 27.76119$, but $f_c^{0.5} <= 8.3$ MPa (22.5.3.1, ACI 318-14)

$pw = A_s / (b_w \cdot d) = 0.00331157$

A_s (tension reinf.) = 709.9999

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / Mu < 1 = 1.00$

$Mu = 1.1510E+006$

$V_u = 9840.634$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 385997.017$

$V_{s1} = 350811.18$ is calculated for jacket, with:

$d = 536.00$

$A_v = 157079.633$

$f_y = 625.00$

$s = 150.00$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)

$V_{s2} = 35185.838$ is calculated for jacket, with:

$d_2 = 400.00$

$A_v = 100530.965$

$f_y = 525.00$

$s = 300.00$

Vs2 has been multiplied by 2(1-s/d) (s>d/2, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$$V_f \text{ ((11-3)-(11.4), ACI 440) } = 0.00$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 750430.726$$

Calculation of Shear Strength at edge 2, Vr2 = 578810.994

$$V_{r2} = V_n \text{ ((22.5.1.1), ACI 318-14)}$$

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf' where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: Vc = 192813.976

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 27.76119$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$$p_w = A_s / (b_w \cdot d) = 0.00331157$$

$$A_s \text{ (tension reinf.)} = 709.9999$$

$$b_w = 400.00$$

$$d = 536.00$$

$$V_u \cdot d / M_u < 1 = 1.00$$

$$M_u = 1.1510E+006$$

$$V_u = 9840.632$$

From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 385997.017

Vs1 = 350811.18 is calculated for jacket, with:

$$d = 536.00$$

$$A_v = 157079.633$$

$$f_y = 625.00$$

$$s = 150.00$$

Vs1 has been multiplied by 1 (s<d/2, according to ASCE 41-17,10.3.4)

Vs2 = 35185.838 is calculated for jacket, with:

$$d = 400.00$$

$$A_v = 100530.965$$

$$f_y = 525.00$$

$$s = 300.00$$

Vs2 has been multiplied by 2(1-s/d) (s>d/2, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$$V_f \text{ ((11-3)-(11.4), ACI 440) } = 0.00$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 750430.726$$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

Knowledge Factor, = 0.87

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 656.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou, \min} > 1$)

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = -9.0372119E-015$

EDGE -B-

Shear Force, $V_b = 9.0372119E-015$

BOTH EDGES

Axial Force, $F = -2309.833$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 709.9999$

-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 , $V_e/V_r = 0.55914272$

Member Controlled by Flexure ($V_e/V_r < 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n / 2 = 218168.257$

with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 3.2725E+008$

$M_{u1+} = 3.2725E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$M_{u1-} = 3.2725E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 3.2725E+008$

$M_{u2+} = 3.2725E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

$M_{u2-} = 3.2725E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

and

$\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$

with

$V_1 = -9.0372119E-015$, is the shear force acting at edge 1 for the the static loading combination

$V_2 = 9.0372119E-015$, is the shear force acting at edge 2 for the the static loading combination

Calculation of M_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 0.00010507$$

$$\mu = 3.2725E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_o(5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.0053097$$

$$w_e(5.4c) = 0.00204688$$

$$a_{se}((5.4d), \text{TBDY}) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.45559$$

$$p_{s1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.38519$$

$$p_{s1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 886.8103$$

$$fy_1 = 739.0086$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o / l_{o, \min} = l_b / d = 1.00$$

$$su_1 = 0.4 * e_{su1_nominal}((5.5), \text{TBDY}) = 0.032$$

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 $fs1 = (fs_{jacket} \cdot Asl_{ten,jacket} + fs_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 739.0086$

with $Es1 = (Es_{jacket} \cdot Asl_{ten,jacket} + Es_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 200000.00$

$y2 = 0.0025$

$sh2 = 0.008$

$ft2 = 886.8103$

$fy2 = 739.0086$

$su2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$

and also multiplied by the $shear_factor$ according to 15.7.1.4, with

$Shear_factor = 1.00$

$lo/lou, min = lb/lb, min = 1.00$

$su2 = 0.4 \cdot esu2_nominal$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 739.0086$

with $Es2 = (Es_{jacket} \cdot Asl_{com,jacket} + Es_{core} \cdot Asl_{com,core}) / Asl_{com} = 200000.00$

$yv = 0.0025$

$shv = 0.008$

$ftv = 895.9746$

$fyv = 746.6455$

$suv = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$

and also multiplied by the $shear_factor$ according to 15.7.1.4, with

$Shear_factor = 1.00$

$lo/lou, min = lb/ld = 1.00$

$suv = 0.4 \cdot esuv_nominal$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esuv_nominal = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered

characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 746.6455$

with $Esv = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$

$1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.09382814$

$2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.09382814$

$v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.05785932$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

fcc (5A.2, TBDY) = 30.00

cc (5A.5, TBDY) = 0.002

$c =$ confinement factor = 1.00

$1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.11251192$

$2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.11251192$

$v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.06938071$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

$v < vs,c$ - RHS eq.(4.5) is satisfied

--->

su (4.9) = 0.1468828

$Mu = MRc$ (4.14) = 3.2725E+008

$u = su$ (4.1) = 0.00010507

Calculation of ratio lb/ld

Adequate Lap Length: $lb/ld \geq 1$

Calculation of Mu1-

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\mu = 0.00010507$$

$$Mu = 3.2725E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu_c, \mu_{cc}) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu_c = 0.0053097$$

$$\mu_{cc} \text{ (5.4c)} = 0.00204688$$

$$\text{ase ((5.4d), TBDY)} = (\text{ase}_1 * A_{ext} + \text{ase}_2 * A_{int}) / A_{sec} = 0.14776895$$

$$\text{ase}_1 = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\text{ase}_2 = \text{Max}(\text{ase}_1, \text{ase}_2) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\text{psh}_{\min} * F_{ywe} = \text{Min}(\text{psh}_{x} * F_{ywe}, \text{psh}_{y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $\text{psh}_{\min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\text{psh}_{x} * F_{ywe} = \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 2.45559$$

$$\text{ps}_1 \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\text{ps}_2 \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\text{psh}_{y} * F_{ywe} = \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 1.38519$$

$$\text{ps}_1 \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\text{ps}_2 \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 886.8103$$

$$fy_1 = 739.0086$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 739.0086

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025

sh2 = 0.008

ft2 = 886.8103

fy2 = 739.0086

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 895.9746

fyv = 746.6455

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814

2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814

v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 30.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192

2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192

v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

v < vs,c - RHS eq.(4.5) is satisfied

---->

su (4.9) = 0.1468828

Mu = MRc (4.14) = 3.2725E+008

u = su (4.1) = 0.00010507

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of μ_{2+}

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$u = 0.00010507$$

$$\mu = 3.2725E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.0053097$$

$$w_e \text{ (5.4c)} = 0.00204688$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.45559$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.38519$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

y1 = 0.0025
sh1 = 0.008
ft1 = 886.8103
fy1 = 739.0086
su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 739.0086

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025
sh2 = 0.008
ft2 = 886.8103
fy2 = 739.0086
su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025
shv = 0.008
ftv = 895.9746
fyv = 746.6455
suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814

2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814

v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 30.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192

2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192

v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

v < vs,c - RHS eq.(4.5) is satisfied

---->

su (4.9) = 0.1468828
Mu = MRc (4.14) = 3.2725E+008
u = su (4.1) = 0.00010507

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 0.00010507
Mu = 3.2725E+008

with full section properties:

b = 670.00
d = 357.00
d' = 43.00
v = 0.0003219
N = 2309.833
fc = 30.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0053097

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.0053097

we (5.4c) = 0.00204688

ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895

ase1 = 0.14776895

bo_1 = 340.00

ho_1 = 610.00

bi2_1 = 975400.00

ase2 = Max(ase1,ase2) = 0.14776895

bo_2 = 192.00

ho_2 = 492.00

bi2_2 = 557856.00

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.38519

Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.45559

ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799

Ash1 = Astir_1*ns_1 = 157.0796

No stirups, ns_1 = 2.00

h1 = 670.00

ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519

Ash2 = Astir_2*ns_2 = 100.531

No stirups, ns_2 = 2.00

h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.38519

ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298

Ash1 = Astir_1*ns_1 = 157.0796

No stirups, ns_1 = 2.00

h1 = 400.00

ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008

Ash2 = Astir_2*ns_2 = 100.531

No stirups, ns_2 = 2.00

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

$$fy_{we1} = 781.25$$

$$fy_{we2} = 656.25$$

$$f_{ce} = 30.00$$

From ((5.A.5), TBDY), TBDY: $cc = 0.002$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 886.8103$$

$$fy_1 = 739.0086$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$su_1 = 0.4 * esu_{1, \text{nominal}} ((5.5), \text{TBDY}) = 0.032$$

From table 5A.1, TBDY: $esu_{1, \text{nominal}} = 0.08$,

For calculation of $esu_{1, \text{nominal}}$ and y_1, sh_1, ft_1, fy_1 , it is considered
characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_1 = (fs_{\text{jacket}} * Asl, \text{ten, jacket} + fs_{\text{core}} * Asl, \text{ten, core}) / Asl, \text{ten} = 739.0086$$

$$\text{with } Es_1 = (Es_{\text{jacket}} * Asl, \text{ten, jacket} + Es_{\text{core}} * Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 886.8103$$

$$fy_2 = 739.0086$$

$$su_2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 1.00$$

$$su_2 = 0.4 * esu_{2, \text{nominal}} ((5.5), \text{TBDY}) = 0.032$$

From table 5A.1, TBDY: $esu_{2, \text{nominal}} = 0.08$,

For calculation of $esu_{2, \text{nominal}}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_2 = (fs_{\text{jacket}} * Asl, \text{com, jacket} + fs_{\text{core}} * Asl, \text{com, core}) / Asl, \text{com} = 739.0086$$

$$\text{with } Es_2 = (Es_{\text{jacket}} * Asl, \text{com, jacket} + Es_{\text{core}} * Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 895.9746$$

$$fy_v = 746.6455$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$suv = 0.4 * esuv_{\text{nominal}} ((5.5), \text{TBDY}) = 0.032$$

From table 5A.1, TBDY: $esuv_{\text{nominal}} = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_{\text{nominal}}$ and y_v, sh_v, ft_v, fy_v , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = (fs_{\text{jacket}} * Asl, \text{mid, jacket} + fs_{\text{mid}} * Asl, \text{mid, core}) / Asl, \text{mid} = 746.6455$$

$$\text{with } Es_v = (Es_{\text{jacket}} * Asl, \text{mid, jacket} + Es_{\text{mid}} * Asl, \text{mid, core}) / Asl, \text{mid} = 200000.00$$

$$1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.09382814$$

$$2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.09382814$$

$$v = Asl, \text{mid} / (b * d) * (fsv / f_c) = 0.05785932$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc (5A.2, \text{TBDY}) = 30.00$$

$$cc (5A.5, \text{TBDY}) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.11251192$$

$$2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.11251192$$

$$v = Asl, \text{mid} / (b * d) * (fsv / f_c) = 0.06938071$$

Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)

--->
v < vs,c - RHS eq.(4.5) is satisfied

---->
su (4.9) = 0.1468828
Mu = MRc (4.14) = 3.2725E+008
u = su (4.1) = 0.00010507

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 390183.487

Calculation of Shear Strength at edge 1, Vr1 = 390183.487
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 = 180743.977
= 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 27.76119, but fc'^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
pw = As/(bw*d) = 0.00331157
As (tension reinf.) = 709.9999
bw = 670.00
d = 320.00
Vu*d/Mu < 1 = 0.00
Mu = 6.8565666E-012
Vu = 9.0372119E-015
From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 209439.51
Vs1 = 209439.51 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 has been multiplied by 1 (s < d/2, according to ASCE 41-17,10.3.4)
Vs2 = 0.00 is calculated for jacket, with:
d2 = 160.00
Av = 100530.965
fy = 525.00
s = 300.00
Vs2 is considered 0 (s > d, according to ASCE 41-17,10.3.4)
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 750430.726

Calculation of Shear Strength at edge 2, Vr2 = 390183.487
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 = 180743.977
= 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 27.76119, but fc'^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
pw = As/(bw*d) = 0.00331157
As (tension reinf.) = 709.9999
bw = 670.00
d = 320.00
Vu*d/Mu < 1 = 0.00

$$\mu_u = 2.0256286E-011$$

$$\nu_u = 9.0372119E-015$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$

$V_{s1} = 209439.51$ is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 625.00$$

$$s = 150.00$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 0.00$ is calculated for jacket, with:

$$d = 160.00$$

$$A_v = 100530.965$$

$$f_y = 525.00$$

$$s = 300.00$$

V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

V_f ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 0.87$

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_b/d \geq 1$)

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 2.8583610E-011$

Shear Force, $V_2 = 2.4489115E-014$

Shear Force, $V_3 = 1166.41$

Axial Force, $F = -9608.729$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: Asl_t = 709.9999

-Compression: Asl_c = 1668.186

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl_{ten} = 911.0619

-Compression: Asl_{com} = 911.0619

-Middle: Asl_{mid} = 556.0619

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl_{ten,jacket} = 603.1858

-Compression: Asl_{com,jacket} = 603.1858

-Middle: Asl_{mid,jacket} = 402.1239

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl_{ten,core} = 307.8761

-Compression: Asl_{com,core} = 307.8761

-Middle: Asl_{mid,core} = 153.938

Mean Diameter of Tension Reinforcement, DbL = 15.20

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = \alpha u = 0.02097574$
 $u = \gamma + \rho = 0.02411005$

- Calculation of γ -

$\gamma = (M_y * L_s / 3) / E_{eff} = 0.00411005$ ((4.29), Biskinis Phd))

$M_y = 2.1288E+008$

$L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 1500.00

From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 2.5898E+013$

Calculation of Yielding Moment M_y

Calculation of γ and M_y according to Annex 7 -

$\gamma = \text{Min}(\gamma_{ten}, \gamma_{com})$

$\gamma_{ten} = 1.0755102E-005$

with $f_y = 625.00$

$d = 357.00$

$\gamma = 0.22825315$

$A = 0.01001045$

$B = 0.0056379$

with $p_t = 0.00380895$

$p_c = 0.00380895$

$p_v = 0.00232477$

$N = 9608.729$

$b = 670.00$

$\alpha = 0.12044818$

$\gamma_{comp} = 2.5830452E-005$

with $f_c = 27.76119$

$E_c = 25742.96$

$\gamma = 0.22747572$

$A = 0.00984691$

$B = 0.00557012$

with $E_s = 200000.00$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

- Calculation of ρ -

From table 10-7: $\rho = 0.02$

with:

- Condition i occurred
- Beam controlled by flexure: $V_p/V_o \leq 1$
- shear control ratio $V_p/V_o = 0.55914272$
- Transverse Reinforcement: NC
- Stirrup Spacing $> d/3$
- Low ductility demand, $\lambda / y < 2$ (table 10-6, ASCE 41-17)
- = $-5.0103204E-022$
- Stirrup Spacing $\leq d/2$
- $d = d_{\text{external}} = 357.00$
- $s = s_{\text{external}} = 150.00$
- Strength provided by hoops $V_s < 3/4 \cdot \text{design Shear}$
- $V_s = 237588.18$, already given in calculation of shear control ratio
- design Shear = $2.4489115E-014$
- $(\lambda - 1) / \lambda \cdot \text{bal} = -0.33327376$
- = $A_{st}/(b_w \cdot d) = 0.00296835$
- Tension Reinf Area: $A_{st} = 709.9999$
- $\lambda = A_{sc}/(b_w \cdot d) = 0.00697431$
- Compression Reinf Area: $A_{sc} = 1668.186$
- From (B-1), ACI 318-11: $\text{bal} = 0.01202003$
- $f_c = (f_{c_jacket} \cdot \text{Area}_{\text{jacket}} + f_{c_core} \cdot \text{Area}_{\text{core}}) / \text{section_area} = 27.76119$
- $f_y = f_{y_jacket_bars} = 625.00$
- From 10.2.7.3, ACI 318-11: $\lambda = 0.65$
- From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + \lambda) = 0.48979592$
- $\lambda = 0.003125$
- $V / (b_w \cdot d \cdot f_c^{0.5}) = 2.3400990E-019$, NOTE: units in lb & in
- $b_w = 670.00$

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 13

beam B1, Floor 1

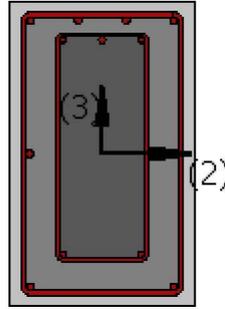
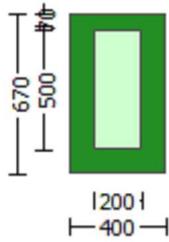
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 420.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{o,min} = l_b/l_d \geq 1$)

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 2.8583610E-011$

Shear Force, $V_a = 2.4489115E-014$

EDGE -B-

Bending Moment, $M_b = 4.4683392E-011$

Shear Force, $V_b = -2.4489115E-014$

BOTH EDGES

Axial Force, $F = -9608.729$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 709.9999$

-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: $Asl_{mid} = 556.0619$

Mean Diameter of Tension Reinforcement, $DbL_{ten} = 15.20$

Existing component: From table 7-7, ASCE 41-17: Final Shear Capacity $VR = *Vn = 274161.749$
 $Vn ((22.5.1.1), ACI 318-14) = 315128.448$

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: $Vc = 147576.839$
= 1 (normal-weight concrete)
Mean concrete strength: $fc' = (fc'_{jacket} * Area_{jacket} + fc'_{core} * Area_{core}) / Area_{section} = 18.50746$, 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 = 4.4683392E-011
Vu = 2.4489115E-014
From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 167551.608$
 $Vs1 = 167551.608$ is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 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
Av = 100530.965
fy = 420.00
s = 300.00
Vs2 is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $Vs + Vf < = 612724.122$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 14

beam B1, Floor 1

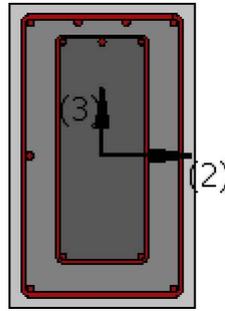
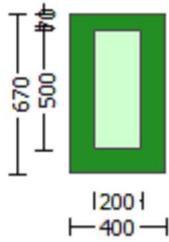
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (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, $\gamma = 0.87$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 656.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou, \min} \geq 1$)

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 9840.634$

EDGE -B-

Shear Force, $V_b = 9840.632$

BOTH EDGES

Axial Force, $F = -2309.833$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_t = 709.9999$
-Compression: $As_c = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{t,ten} = 709.9999$
-Compression: $As_{c,com} = 1266.062$
-Middle: $As_{c,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.92480584$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 535287.788$
with

$M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 7.8817E+008$
 $Mu_{1+} = 4.6479E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
 $Mu_{1-} = 7.8817E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 7.8817E+008$
 $Mu_{2+} = 4.6479E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination
 $Mu_{2-} = 7.8817E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = 9840.634$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 9840.632$, is the shear force acting at edge 2 for the static loading combination

Calculation of Mu_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 5.6369735E-005$
 $M_u = 4.6479E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.000307$
 $N = 2309.833$
 $f_c = 30.00$
 $\alpha_1(5A.5, TBDY) = 0.002$
Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.0053097$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\phi_u = 0.0053097$
 $w_e(5.4c) = 0.00204688$
 $ase((5.4d), TBDY) = (ase_1 \cdot A_{ext} + ase_2 \cdot A_{int})/A_{sec} = 0.14776895$
 $ase_1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi_2_1 = 975400.00$
 $ase_2 = \text{Max}(ase_1, ase_2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi_2_2 = 557856.00$
 $psh_{min} \cdot F_{ywe} = \text{Min}(psh_x \cdot F_{ywe}, psh_y \cdot F_{ywe}) = 1.38519$
Expression ((5.4d), TBDY) for $psh_{min} \cdot F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $psh_x \cdot F_{ywe} = psh_1 \cdot F_{ywe1} + ps_2 \cdot F_{ywe2} = 2.45559$

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 = 1.38519
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 = 781.25
fywe2 = 656.25
fce = 30.00

From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00

y1 = 0.0025
sh1 = 0.008
ft1 = 872.4558
fy1 = 727.0465
su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

su1 = $0.4 \cdot esu1_nominal$ ((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 = $(fs_jacket \cdot Asl,ten,jacket + fs_core \cdot Asl,ten,core) / Asl,ten = 727.0465$

with Es1 = $(Es_jacket \cdot Asl,ten,jacket + Es_core \cdot Asl,ten,core) / Asl,ten = 200000.00$

y2 = 0.0025
sh2 = 0.008
ft2 = 882.7854
fy2 = 735.6545
su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = $0.4 \cdot esu2_nominal$ ((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 = $(fs_jacket \cdot Asl,com,jacket + fs_core \cdot Asl,com,core) / Asl,com = 735.6545$

with Es2 = $(Es_jacket \cdot Asl,com,jacket + Es_core \cdot Asl,com,core) / Asl,com = 200000.00$

yv = 0.0025
shv = 0.008
ftv = 937.50
fyv = 781.25
suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_0/l_{ou,min} = l_b/l_d = 1.00$$

$$s_{uv} = 0.4 * e_{suv_nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{suv_nominal} = 0.08$,

considering characteristic value $f_{sv} = f_{sv}/1.2$, 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.

$$\text{with } f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 781.25$$

$$\text{with } E_{sv} = (E_{s,jacket} * A_{s,mid,jacket} + E_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 200000.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.06860752$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.12378842$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.04175429$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 30.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.08477074$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.15295169$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.05159117$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.09460844$$

$$M_u = M_{Rc} (4.14) = 4.6479E+008$$

$$u = s_u (4.1) = 5.6369735E-005$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of M_{u1} -

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 6.0907698E-005$$

$$M_u = 7.8817E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\phi_{cu} = 0.0053097$

$$\text{we (5.4c)} = 0.00204688$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$psh_{min} * Fy_{we} = \text{Min}(psh_x * Fy_{we}, psh_y * Fy_{we}) = 1.38519$$

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)

$$psh_x * Fy_{we} = psh_1 * Fy_{we1} + ps_2 * Fy_{we2} = 2.45559$$

$$ps_1 \text{ (external)} = (Ash_1 * h_1 / s_1) / A_{sec} = 0.00261799$$

$$Ash_1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h_1 = 670.00$$

$$ps_2 \text{ (internal)} = (Ash_2 * h_2 / s_2) / A_{sec} = 0.00062519$$

$$Ash_2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h_2 = 500.00$$

$$psh_y * Fy_{we} = psh_1 * Fy_{we1} + ps_2 * Fy_{we2} = 1.38519$$

$$ps_1 \text{ (external)} = (Ash_1 * h_1 / s_1) / A_{sec} = 0.00156298$$

$$Ash_1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h_1 = 400.00$$

$$ps_2 \text{ (internal)} = (Ash_2 * h_2 / s_2) / A_{sec} = 0.00025008$$

$$Ash_2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$fy_{we1} = 781.25$$

$$fy_{we2} = 656.25$$

$$f_{ce} = 30.00$$

From ((5.A5), TBDY), TBDY: $cc = 0.002$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 882.7854$$

$$fy_1 = 735.6545$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$lo/lou_{min} = lb/l_d = 1.00$$

$$su_1 = 0.4 * esu_{1_nominal} \text{ ((5.5), TBDY)} = 0.032$$

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.

$$\text{with } fs_1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 735.6545$$

$$\text{with } Es_1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$$

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 872.4558$$

$$fy_2 = 727.0465$$

$$su_2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$lo/lou_{min} = lb/l_{b,min} = 1.00$$

$$su_2 = 0.4 * esu_{2_nominal} \text{ ((5.5), TBDY)} = 0.032$$

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.

$$\text{with } fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 727.0465$$

$$\text{with } Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 937.50$$

$f_{yv} = 781.25$
 $s_{uv} = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 1.00$
 $s_{uv} = 0.4 * e_{suv_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $e_{suv_nominal} = 0.08$,
 considering characteristic value $f_{sv} = f_{sv}/1.2$, 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 $f_{sv} = (f_{s,jacket} * A_{sl,mid,jacket} + f_{s,mid} * A_{sl,mid,core}) / A_{sl,mid} = 781.25$
 with $E_{sv} = (E_{s,jacket} * A_{sl,mid,jacket} + E_{s,mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$
 $1 = A_{sl,ten} / (b * d) * (f_{s1} / f_c) = 0.12378842$
 $2 = A_{sl,com} / (b * d) * (f_{s2} / f_c) = 0.06860752$
 $v = A_{sl,mid} / (b * d) * (f_{sv} / f_c) = 0.04175429$
 and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten} / (b * d) * (f_{s1} / f_c) = 0.15295169$
 $2 = A_{sl,com} / (b * d) * (f_{s2} / f_c) = 0.08477074$
 $v = A_{sl,mid} / (b * d) * (f_{sv} / f_c) = 0.05159117$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is not satisfied
 --->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied
 --->

$su (4.8) = 0.16206515$
 $Mu = MRc (4.15) = 7.8817E+008$
 $u = su (4.1) = 6.0907698E-005$

 Calculation of ratio l_b/l_d

 Adequate Lap Length: $l_b/l_d \geq 1$

 Calculation of Mu_{2+}

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 5.6369735E-005$
 $Mu = 4.6479E+008$

 with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.000307$
 $N = 2309.833$
 $f_c = 30.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0053097$
 $w_e (5.4c) = 0.00204688$
 $ase ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$
 $ase1 = 0.14776895$

bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.38519

Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.45559
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.38519
ps1 (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 = 781.25

fywe2 = 656.25

fce = 30.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 872.4558

fy1 = 727.0465

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 727.0465

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025

sh2 = 0.008

ft2 = 882.7854

fy2 = 735.6545

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered

characteristic value $f_{s2} = f_{s2}/1.2$, 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 $f_{s2} = (f_{s,jacket} \cdot A_{s,com,jacket} + f_{s,core} \cdot A_{s,com,core})/A_{s,com} = 735.6545$

with $E_{s2} = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core})/A_{s,com} = 200000.00$

$y_v = 0.0025$

$sh_v = 0.008$

$ft_v = 937.50$

$fy_v = 781.25$

$s_{uv} = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$l_o/l_{o,min} = l_b/l_d = 1.00$

$s_{uv} = 0.4 \cdot e_{suv,nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $e_{suv,nominal} = 0.08$,

considering characteristic value $f_{sv} = f_{sv}/1.2$, 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 $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core})/A_{s,mid} = 781.25$

with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core})/A_{s,mid} = 200000.00$

1 = $A_{s,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.06860752$

2 = $A_{s,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.12378842$

$v = A_{s,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.04175429$

and confined core properties:

$b = 340.00$

$d = 597.00$

$d' = 13.00$

$f_{cc} (5A.2, TBDY) = 30.00$

$cc (5A.5, TBDY) = 0.002$

$c = \text{confinement factor} = 1.00$

1 = $A_{s,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.08477074$

2 = $A_{s,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.15295169$

$v = A_{s,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.05159117$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$\mu_u (4.9) = 0.09460844$

$M_u = M_{Rc} (4.14) = 4.6479E+008$

$u = \mu_u (4.1) = 5.6369735E-005$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of μ_{u2} -

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:

$u = 6.0907698E-005$

$M_u = 7.8817E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.000307$

$N = 2309.833$

$f_c = 30.00$

$cc (5A.5, TBDY) = 0.002$

Final value of μ_u : $\mu_u^* = \text{shear_factor} \cdot \text{Max}(\mu_u, cc) = 0.0053097$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $c_u = 0.0053097$

w_e (5.4c) = 0.00204688

a_{se} ((5.4d), TBDY) = $(a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o,1} = 340.00$

$h_{o,1} = 610.00$

$b_{i2,1} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o,2} = 192.00$

$h_{o,2} = 492.00$

$b_{i2,2} = 557856.00$

$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.38519$

Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.45559$

p_{s1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir,1} * n_{s,1} = 157.0796$

No stirrups, $n_{s,1} = 2.00$

$h_1 = 670.00$

p_{s2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$

$A_{sh2} = A_{stir,2} * n_{s,2} = 100.531$

No stirrups, $n_{s,2} = 2.00$

$h_2 = 500.00$

 $p_{sh,y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.38519$

p_{s1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$

$A_{sh1} = A_{stir,1} * n_{s,1} = 157.0796$

No stirrups, $n_{s,1} = 2.00$

$h_1 = 400.00$

p_{s2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$

$A_{sh2} = A_{stir,2} * n_{s,2} = 100.531$

No stirrups, $n_{s,2} = 2.00$

$h_2 = 200.00$

 $A_{sec} = 268000.00$

$s_1 = 150.00$

$s_2 = 300.00$

$f_{ywe1} = 781.25$

$f_{ywe2} = 656.25$

$f_{ce} = 30.00$

From ((5.A5), TBDY), TBDY: $c_c = 0.002$

c = confinement factor = 1.00

$y_1 = 0.0025$

$sh_1 = 0.008$

$ft_1 = 882.7854$

$fy_1 = 735.6545$

$su_1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$l_o / l_{ou, \min} = l_b / l_d = 1.00$

$su_1 = 0.4 * esu_{1, \text{nominal}} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu_{1, \text{nominal}} = 0.08$,

For calculation of $esu_{1, \text{nominal}}$ and y_1, sh_1, ft_1, fy_1 , it is considered
characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 735.6545$

with $Es_1 = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$

$y_2 = 0.0025$

$sh_2 = 0.008$

$ft_2 = 872.4558$

$fy_2 = 727.0465$

$su_2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 727.0465

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 937.50

fyv = 781.25

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered characteristic value 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 = 781.25

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.12378842

2 = Asl,com/(b*d)*(fs2/fc) = 0.06860752

v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 30.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.15295169

2 = Asl,com/(b*d)*(fs2/fc) = 0.08477074

v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

v < vs,y2 - LHS eq.(4.5) is not satisfied

--->

v < vs,c - RHS eq.(4.5) is satisfied

--->

su (4.8) = 0.16206515

Mu = MRc (4.15) = 7.8817E+008

u = su (4.1) = 6.0907698E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 578810.994

Calculation of Shear Strength at edge 1, Vr1 = 578810.994

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 = 192813.976

= 1 (normal-weight concrete)
Mean concrete strength: $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 27.76119$, but $f_c'^{0.5} < = 8.3$ MPa (22.5.3.1, ACI 318-14)
 $p_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu < 1 = 1.00$
 $\mu = 1.1510E+006$
 $V_u = 9840.634$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 385997.017$
 $V_{s1} = 350811.18$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 35185.838$ is calculated for jacket, with:
 $d_2 = 400.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f < = 750430.726$

Calculation of Shear Strength at edge 2, $V_{r2} = 578810.994$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf' where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 192813.976$
= 1 (normal-weight concrete)
Mean concrete strength: $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 27.76119$, but $f_c'^{0.5} < = 8.3$ MPa (22.5.3.1, ACI 318-14)
 $p_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu < 1 = 1.00$
 $\mu = 1.1510E+006$
 $V_u = 9840.632$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 385997.017$
 $V_{s1} = 350811.18$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 35185.838$ is calculated for jacket, with:
 $d = 400.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f < = 750430.726$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 0.87$
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$
New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$
Concrete Elasticity, $E_c = 25742.96$
Steel Elasticity, $E_s = 200000.00$
Existing Column
Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$
Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$
Concrete Elasticity, $E_c = 23025.204$
Steel Elasticity, $E_s = 200000.00$

Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket
New material: Steel Strength, $f_s = 1.25 * f_{sm} = 781.25$
Existing Column
Existing material: Steel Strength, $f_s = 1.25 * f_{sm} = 656.25$
#####

External Height, $H = 670.00$
External Width, $W = 400.00$
Internal Height, $H = 500.00$
Internal Width, $W = 200.00$
Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.00
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_o/l_{ou,min} > 1$)
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = -9.0372119E-015$
EDGE -B-
Shear Force, $V_b = 9.0372119E-015$
BOTH EDGES
Axial Force, $F = -2309.833$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl} = 709.9999$
-Compression: $A_{slc} = 1668.186$
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, $V_e/V_r = 0.55914272$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u * l_n / 2 = 218168.257$

with
 $Mpr1 = \text{Max}(\text{Mu}1+, \text{Mu}1-) = 3.2725\text{E}+008$
 $\text{Mu}1+ = 3.2725\text{E}+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
 $\text{Mu}1- = 3.2725\text{E}+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
 $Mpr2 = \text{Max}(\text{Mu}2+, \text{Mu}2-) = 3.2725\text{E}+008$
 $\text{Mu}2+ = 3.2725\text{E}+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
 $\text{Mu}2- = 3.2725\text{E}+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination
and
 $\pm v_w \cdot l_n = (|V1| + |V2|)/2$
with
 $V1 = -9.0372119\text{E}-015$, is the shear force acting at edge 1 for the the static loading combination
 $V2 = 9.0372119\text{E}-015$, is the shear force acting at edge 2 for the the static loading combination

Calculation of $\text{Mu}1+$

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $u = 0.00010507$
 $\text{Mu} = 3.2725\text{E}+008$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.0003219$
 $N = 2309.833$
 $f_c = 30.00$
 $\phi_c (5A.5, \text{TBDY}) = 0.002$
Final value of ϕ_{cu} : $\phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0053097$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\phi_{cu} = 0.0053097$
 $\phi_{we} (5.4c) = 0.00204688$
 $\phi_{ase} ((5.4d), \text{TBDY}) = (\phi_{ase1} * A_{ext} + \phi_{ase2} * A_{int}) / A_{sec} = 0.14776895$
 $\phi_{ase1} = 0.14776895$
 $\phi_{bo_1} = 340.00$
 $\phi_{ho_1} = 610.00$
 $\phi_{bi2_1} = 975400.00$
 $\phi_{ase2} = \text{Max}(\phi_{ase1}, \phi_{ase2}) = 0.14776895$
 $\phi_{bo_2} = 192.00$
 $\phi_{ho_2} = 492.00$
 $\phi_{bi2_2} = 557856.00$
 $\phi_{psh, \min} * F_{ywe} = \text{Min}(\phi_{psh, x} * F_{ywe}, \phi_{psh, y} * F_{ywe}) = 1.38519$
Expression ((5.4d), TBDY) for $\phi_{psh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $\phi_{psh, x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{ps2} * F_{ywe2} = 2.45559$
 $\phi_{ps1} (\text{external}) = (\phi_{Ash1} * h1 / s1) / A_{sec} = 0.00261799$
 $\phi_{Ash1} = \phi_{Astir_1} * ns_1 = 157.0796$
No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $\phi_{ps2} (\text{internal}) = (\phi_{Ash2} * h2 / s2) / A_{sec} = 0.00062519$
 $\phi_{Ash2} = \phi_{Astir_2} * ns_2 = 100.531$
No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

$\phi_{psh, y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{ps2} * F_{ywe2} = 1.38519$
 $\phi_{ps1} (\text{external}) = (\phi_{Ash1} * h1 / s1) / A_{sec} = 0.00156298$
 $\phi_{Ash1} = \phi_{Astir_1} * ns_1 = 157.0796$
No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $\phi_{ps2} (\text{internal}) = (\phi_{Ash2} * h2 / s2) / A_{sec} = 0.00025008$

Ash2 = Astir₂*ns₂ = 100.531
No stirups, ns₂ = 2.00
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 781.25

fywe2 = 656.25

fce = 30.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 886.8103

fy1 = 739.0086

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^{2/3}), from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 739.0086

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025

sh2 = 0.008

ft2 = 886.8103

fy2 = 739.0086

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^{2/3}), from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 895.9746

fyv = 746.6455

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^{2/3}), from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814

2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814

v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932

and confined core properties:

b = 610.00

d = 327.00

$d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.11251192$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.11251192$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.06938071$
 Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)

--->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied

--->
 $su (4.9) = 0.1468828$
 $Mu = MRc (4.14) = 3.2725E+008$
 $u = su (4.1) = 0.00010507$

 Calculation of ratio l_b/d

 Adequate Lap Length: $l_b/d \geq 1$

 Calculation of $Mu1$ -

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 0.00010507$
 $Mu = 3.2725E+008$

 with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.0003219$
 $N = 2309.833$
 $f_c = 30.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0053097$
 $w_e (5.4c) = 0.00204688$
 $ase ((5.4d), TBDY) = (ase1*A_{ext} + ase2*A_{int})/A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$
 $psh, \min * F_{ywe} = \text{Min}(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.38519$
 Expression ((5.4d), TBDY) for $psh, \min * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $psh, x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.45559$
 $ps1$ (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, $ns_2 = 2.00$
 $h2 = 500.00$

 $psh, y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.38519$

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$$

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$$

$$Ash2 = Astir_2 \cdot ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 781.25$$

$$fywe2 = 656.25$$

$$fce = 30.00$$

$$\text{From } ((5.A.5), \text{ TBDY}), \text{ TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 886.8103$$

$$fy1 = 739.0086$$

$$su1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \text{min} = lb/ld = 1.00$$

$$su1 = 0.4 \cdot esu1_{\text{nominal}} ((5.5), \text{ TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu1_{\text{nominal}} = 0.08,$$

For calculation of $esu1_{\text{nominal}}$ and $y1, sh1, ft1, fy1$, it is considered
characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs1 = (fs_{\text{jacket}} \cdot Asl, \text{ten, jacket} + fs_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 739.0086$$

$$\text{with } Es1 = (Es_{\text{jacket}} \cdot Asl, \text{ten, jacket} + Es_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 886.8103$$

$$fy2 = 739.0086$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \text{min} = lb/lb, \text{min} = 1.00$$

$$su2 = 0.4 \cdot esu2_{\text{nominal}} ((5.5), \text{ TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu2_{\text{nominal}} = 0.08,$$

For calculation of $esu2_{\text{nominal}}$ and $y2, sh2, ft2, fy2$, it is considered
characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

$$y2, sh2, ft2, fy2, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs2 = (fs_{\text{jacket}} \cdot Asl, \text{com, jacket} + fs_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 739.0086$$

$$\text{with } Es2 = (Es_{\text{jacket}} \cdot Asl, \text{com, jacket} + Es_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 895.9746$$

$$fyv = 746.6455$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \text{min} = lb/ld = 1.00$$

$$suv = 0.4 \cdot esuv_{\text{nominal}} ((5.5), \text{ TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esuv_{\text{nominal}} = 0.08,$$

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_{\text{nominal}}$ and yv, shv, ftv, fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fsv = (fs_{\text{jacket}} \cdot Asl, \text{mid, jacket} + fs_{\text{mid}} \cdot Asl, \text{mid, core}) / Asl, \text{mid} = 746.6455$$

$$\text{with } Esv = (Es_{\text{jacket}} \cdot Asl, \text{mid, jacket} + Es_{\text{mid}} \cdot Asl, \text{mid, core}) / Asl, \text{mid} = 200000.00$$

$$1 = Asl, \text{ten} / (b \cdot d) \cdot (fs1 / fce) = 0.09382814$$

$$2 = A_{sl,com}/(b*d)^*(f_s2/f_c) = 0.09382814$$

$$v = A_{sl,mid}/(b*d)^*(f_{sv}/f_c) = 0.05785932$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 30.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{sl,ten}/(b*d)^*(f_{s1}/f_c) = 0.11251192$$

$$2 = A_{sl,com}/(b*d)^*(f_s2/f_c) = 0.11251192$$

$$v = A_{sl,mid}/(b*d)^*(f_{sv}/f_c) = 0.06938071$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.1468828$$

$$M_u = M_{Rc} (4.14) = 3.2725E+008$$

$$u = s_u (4.1) = 0.00010507$$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of M_{u2+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 0.00010507$$

$$M_u = 3.2725E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.0053097$$

$$w_e (5.4c) = 0.00204688$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $p_{sh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh_x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.45559$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.38519
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 781.25

fywe2 = 656.25

fce = 30.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 886.8103

fy1 = 739.0086

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 739.0086

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025

sh2 = 0.008

ft2 = 886.8103

fy2 = 739.0086

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 895.9746

fyv = 746.6455

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered

characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 746.6455$

with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.09382814$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.09382814$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.05785932$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

f_{cc} (5A.2, TBDY) = 30.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.11251192$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.11251192$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.06938071$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

---->

su (4.9) = 0.1468828

$M_u = M_{Rc}$ (4.14) = 3.2725E+008

$u = su$ (4.1) = 0.00010507

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of M_u

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 0.00010507$

$M_u = 3.2725E+008$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.0003219$

$N = 2309.833$

$f_c = 30.00$

cc (5A.5, TBDY) = 0.002

Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.0053097$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $cu = 0.0053097$

we (5.4c) = 0.00204688

ase ((5.4d), TBDY) = $(ase_1 \cdot A_{ext} + ase_2 \cdot A_{int}) / A_{sec} = 0.14776895$

$ase_1 = 0.14776895$

$bo_1 = 340.00$

$ho_1 = 610.00$

$bi_2_1 = 975400.00$

$ase_2 = \text{Max}(ase_1, ase_2) = 0.14776895$

$bo_2 = 192.00$

$ho_2 = 492.00$

$bi_2_2 = 557856.00$

$psh_{min} \cdot F_{ywe} = \text{Min}(psh_x \cdot F_{ywe}, psh_y \cdot F_{ywe}) = 1.38519$

Expression ((5.4d), TBDY) for $psh_{min} \cdot F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $psh_x \cdot F_{ywe} = psh_1 \cdot F_{ywe1} + psh_2 \cdot F_{ywe2} = 2.45559$

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 = 1.38519
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 = 781.25
fywe2 = 656.25
fce = 30.00

From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00

y1 = 0.0025
sh1 = 0.008
ft1 = 886.8103
fy1 = 739.0086
su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

su1 = $0.4 \cdot esu1_nominal$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1, ft1, fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1, ft1, fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = $(fs_jacket \cdot Asl,ten,jacket + fs_core \cdot Asl,ten,core) / Asl,ten = 739.0086$

with Es1 = $(Es_jacket \cdot Asl,ten,jacket + Es_core \cdot Asl,ten,core) / Asl,ten = 200000.00$

y2 = 0.0025
sh2 = 0.008
ft2 = 886.8103
fy2 = 739.0086
su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = $0.4 \cdot esu2_nominal$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2, ft2, fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1, ft1, fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = $(fs_jacket \cdot Asl,com,jacket + fs_core \cdot Asl,com,core) / Asl,com = 739.0086$

with Es2 = $(Es_jacket \cdot Asl,com,jacket + Es_core \cdot Asl,com,core) / Asl,com = 200000.00$

yv = 0.0025
shv = 0.008
ftv = 895.9746
fyv = 746.6455
suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_0/l_{ou,min} = l_b/l_d = 1.00$$

$$s_{uv} = 0.4 * e_{suv,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{suv,nominal} = 0.08$,

considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY

For calculation of $e_{suv,nominal}$ and γ_v , sh_v, ft_v, fy_v , it is considered

characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.

$$\gamma_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b/l_d)^{2/3}), \text{ from } 10.3.5, \text{ ASCE } 41-17.$$

$$\text{with } f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 746.6455$$

$$\text{with } E_{sv} = (E_{s,jacket} * A_{s,mid,jacket} + E_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 200000.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.09382814$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.09382814$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.05785932$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 30.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.11251192$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.11251192$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.06938071$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

---->

$$s_u (4.9) = 0.1468828$$

$$\mu_u = M R_c (4.14) = 3.2725E+008$$

$$u = s_u (4.1) = 0.00010507$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 390183.487$

Calculation of Shear Strength at edge 1, $V_{r1} = 390183.487$

$$V_{r1} = V_n ((22.5.1.1), \text{ACI } 318-14)$$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f^*V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

$$\text{From Table } (22.5.5.1), \text{ACI } 318-14: V_c = 180743.977$$

$$= 1 \text{ (normal-weight concrete)}$$

$$\text{Mean concrete strength: } f'_c = (f'_{c,jacket} * \text{Area}_{jacket} + f'_{c,core} * \text{Area}_{core}) / \text{Area}_{section} = 27.76119, \text{ but } f_c^{0.5} < = 8.3 \text{ MPa } (22.5.3.1, \text{ACI } 318-14)$$

$$p_w = A_s / (b_w * d) = 0.00331157$$

$$A_s \text{ (tension reinf.)} = 709.9999$$

$$b_w = 670.00$$

$$d = 320.00$$

$$V_u * d / \mu_u < 1 = 0.00$$

$$\mu_u = 6.8565666E-012$$

$$V_u = 9.0372119E-015$$

$$\text{From } (11.5.4.8), \text{ACI } 318-14: V_{s1} + V_{s2} = 209439.51$$

$V_{s1} = 209439.51$ is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 625.00$$

$$s = 150.00$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 0.00$ is calculated for jacket, with:

$$d_2 = 160.00$$

$$A_v = 100530.965$$

$$f_y = 525.00$$

$$s = 300.00$$

Vs2 is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

$$V_f \text{ ((11-3)-(11.4), ACI 440)} = 0.00$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 750430.726$$

Calculation of Shear Strength at edge 2, $V_{r2} = 390183.487$

$$V_{r2} = V_n \text{ ((22.5.1.1), ACI 318-14)}$$

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw + f*Vf'

where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_c \text{_{jacket}} * \text{Area}_{\text{jacket}} + f'_c \text{_{core}} * \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 27.76119$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$$p_w = A_s / (b_w * d) = 0.00331157$$

$$A_s \text{ (tension reinf.)} = 709.9999$$

$$b_w = 670.00$$

$$d = 320.00$$

$$V_u * d / \mu_u < 1 = 0.00$$

$$\mu_u = 2.0256286E-011$$

$$V_u = 9.0372119E-015$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$

$V_{s1} = 209439.51$ is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 625.00$$

$$s = 150.00$$

Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs2 = 0.00 is calculated for jacket, with:

$$d = 160.00$$

$$A_v = 100530.965$$

$$f_y = 525.00$$

$$s = 300.00$$

Vs2 is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

$$V_f \text{ ((11-3)-(11.4), ACI 440)} = 0.00$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 750430.726$$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor, = 0.87

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_b/d \geq 1$)
No FRP Wrapping

Stepwise Properties

Bending Moment, M = 1.6981E+007
Shear Force, V2 = -2.4489115E-014
Shear Force, V3 = 18514.856
Axial Force, F = -9608.729
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Asl,ten = 709.9999
-Compression: Asl,com = 1668.186
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 709.9999
-Compression: Asl,com = 1266.062
-Middle: Asl,mid = 402.1239
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 402.1239
-Compression: Asl,com,jacket = 804.2477
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 307.8761
-Compression: Asl,com,core = 461.8141
-Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 15.00

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_{R} = \frac{1}{2} u = 0.02277925$
 $u = y + p = 0.02618304$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00118304$ ((4.29), Biskinis Phd))
 $M_y = 2.9297E+008$
 $L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 917.1471
From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 7.5708E+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 5.8262953E-006$
with $f_y = 625.00$
 $d = 627.00$
 $y = 0.18885675$
 $A = 0.00954705$
 $B = 0.00409845$
with $p_t = 0.00283094$
 $p_c = 0.00504809$

pv = 0.00160336
N = 9608.729
b = 400.00
" = 0.06858054
y_comp = 1.7813453E-005
with fc = 27.76119
Ec = 25742.96
y = 0.18781039
A = 0.00939108
B = 0.0040338
with Es = 200000.00

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

- Calculation of p -

From table 10-7: p = 0.025

with:

- Condition i occurred

Beam controlled by flexure: $V_p/V_o \leq 1$

shear control ratio $V_p/V_o = 0.92480584$

- Transverse Reinforcement: C

- Stirrup Spacing $\leq d/3$

- Low ductility demand, $\rho_y < 2$ (table 10-6, ASCE 41-17)

= 1.8291976E-005

- Stirrup Spacing $\leq d/2$

d = d_external = 627.00

s = s_external = 150.00

- Strength provided by hoops $V_s < 3/4$ *design Shear

$V_s = 421182.855$, already given in calculation of shear control ratio

design Shear = 18514.856

- (-)/ bal = -0.3178459

= $A_{st}/(b_w*d) = 0.00283094$

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 = 0.01202003

fc = $(f_{c_jacket}*Area_jacket + f_{c_core}*Area_core)/section_area = 27.76119$

fy = $f_{y_jacket_bars} = 625.00$

From 10.2.7.3, ACI 318-11: 1 = 0.65

From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + y) = 0.48979592$

y = 0.003125

- $V/(b_w*d*f_c^{0.5}) = 0.16873181$, 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

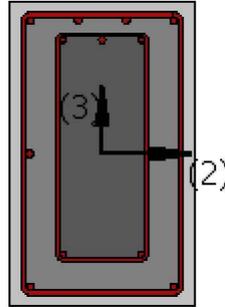
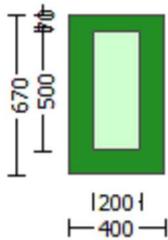
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

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, $\gamma = 0.87$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 420.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou, \min} = l_b/l_d \geq 1$)

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 9.0425E+006$
Shear Force, $V_a = 1166.41$
EDGE -B-
Bending Moment, $M_b = 1.6981E+007$
Shear Force, $V_b = 18514.856$
BOTH EDGES
Axial Force, $F = -9608.729$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 709.9999$
-Compression: $A_{sc} = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten} = 709.9999$
-Compression: $A_{sc,com} = 1266.062$
-Middle: $A_{st,mid} = 402.1239$
Mean Diameter of Tension Reinforcement, $D_{bL,ten} = 15.00$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = \phi V_n = 403182.72$
 V_n ((22.5.1.1), ACI 318-14) = 463428.414

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + \phi V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 154630.80$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c,jacket} \cdot Area_{jacket} + f'_{c,core} \cdot Area_{core}) / Area_{section} = 18.50746$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu < 1 = 0.58442095$
 $\mu = 1.6981E+007$
 $V_u = 18514.856$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 308797.614$
 $V_{s1} = 280648.944$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 500.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 28148.67$ is calculated for core, with:
 $d = 400.00$
 $A_v = 100530.965$
 $f_y = 420.00$
 $s = 300.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 612724.122$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1
At local axis: 3
Integration Section: (b)

Calculation No. 16

beam B1, Floor 1

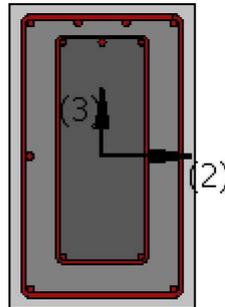
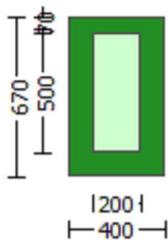
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (θ)

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 0.87$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 656.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.00
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_o/l_{ou}, \min >= 1$)
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, $V_a = 9840.634$
EDGE -B-
Shear Force, $V_b = 9840.632$
BOTH EDGES
Axial Force, $F = -2309.833$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 709.9999$
-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, $V_e/V_r = 0.92480584$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 535287.788$
with
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 7.8817E+008$
 $\mu_{u1+} = 4.6479E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{u1-} = 7.8817E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 7.8817E+008$
 $\mu_{u2+} = 4.6479E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{u2-} = 7.8817E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = 9840.634$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 9840.632$, is the shear force acting at edge 2 for the static loading combination

Calculation of μ_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 5.6369735E-005$
 $\mu_u = 4.6479E+008$

with full section properties:
 $b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.000307$
 $N = 2309.833$

$$f_c = 30.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } c_u = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.0053097$$

$$w_e \text{ (5.4c)} = 0.00204688$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.45559$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.38519$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A.5), TBDY), TBDY: } c_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 872.4558$$

$$fy_1 = 727.0465$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o / l_{ou, \min} = l_b / l_d = 1.00$$

$$su_1 = 0.4 * e_{su1_nominal} \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } e_{su1_nominal} = 0.08,$$

For calculation of $e_{su1_nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered characteristic value $fs_1 = fs_1 / 1.2$, from table 5.1, TBDY.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b / l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 727.0465$$

$$\text{with } E_{s1} = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$$

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 882.7854$$

$$fy_2 = 735.6545$$

$$su_2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o/l_{o,min} = l_b/l_{b,min} = 1.00$$

$$su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,

For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered characteristic value $fs_2 = fs_2/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 735.6545$$

$$\text{with } Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 937.50$$

$$fy_v = 781.25$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o/l_{o,min} = l_b/l_d = 1.00$$

$$suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,

considering characteristic value $fs_v = fs_v/1.2$, 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 $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_v = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 781.25$$

$$\text{with } Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$$

$$1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.06860752$$

$$2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.12378842$$

$$v = A_{sl,mid} / (b * d) * (fs_v / fc) = 0.04175429$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 30.00$$

$$cc (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.08477074$$

$$2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.15295169$$

$$v = A_{sl,mid} / (b * d) * (fs_v / fc) = 0.05159117$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

---->

$$su (4.9) = 0.09460844$$

$$Mu = MRc (4.14) = 4.6479E+008$$

$$u = su (4.1) = 5.6369735E-005$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Mu_1 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 6.0907698E-005$$

$$Mu = 7.8817E+008$$

with full section properties:

b = 400.00
d = 627.00
d' = 43.00
v = 0.000307
N = 2309.833
fc = 30.00
co (5A.5, TBDY) = 0.002

Final value of cu: $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0053097$
The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $cu = 0.0053097$

we (5.4c) = 0.00204688

ase ((5.4d), TBDY) = $(ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$

ase1 = 0.14776895

bo_1 = 340.00

ho_1 = 610.00

bi2_1 = 975400.00

ase2 = $\text{Max}(ase1, ase2) = 0.14776895$

bo_2 = 192.00

ho_2 = 492.00

bi2_2 = 557856.00

$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.38519$

Expression ((5.4d), TBDY) for $psh_{min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.45559$

ps1 (external) = $(A_{sh1} * h1 / s1) / A_{sec} = 0.00261799$

Ash1 = $A_{stir_1} * ns_1 = 157.0796$

No stirrups, ns_1 = 2.00

h1 = 670.00

ps2 (internal) = $(A_{sh2} * h2 / s2) / A_{sec} = 0.00062519$

Ash2 = $A_{stir_2} * ns_2 = 100.531$

No stirrups, ns_2 = 2.00

h2 = 500.00

 $psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.38519$

ps1 (external) = $(A_{sh1} * h1 / s1) / A_{sec} = 0.00156298$

Ash1 = $A_{stir_1} * ns_1 = 157.0796$

No stirrups, ns_1 = 2.00

h1 = 400.00

ps2 (internal) = $(A_{sh2} * h2 / s2) / A_{sec} = 0.00025008$

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 = 781.25

fywe2 = 656.25

fce = 30.00

From ((5.A.5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 882.7854

fy1 = 735.6545

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

su1 = $0.4 * esu1_{nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1, ft1, fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1, ft1, fy1, are also multiplied by $\text{Min}(1, 1.25 * (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = $(fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 735.6545$

$$\text{with } Es1 = (Es_{\text{jacket}} \cdot Asl_{\text{ten,jacket}} + Es_{\text{core}} \cdot Asl_{\text{ten,core}}) / Asl_{\text{ten}} = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 872.4558$$

$$fy2 = 727.0465$$

$$su2 = 0.032$$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

$$lo/lo_{\text{min}} = lb/lb_{\text{min}} = 1.00$$

$$su2 = 0.4 \cdot esu2_{\text{nominal}} ((5.5), \text{TBDY}) = 0.032$$
 From table 5A.1, TBDY: $esu2_{\text{nominal}} = 0.08$,
 For calculation of $esu2_{\text{nominal}}$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs2 = (fs_{\text{jacket}} \cdot Asl_{\text{com,jacket}} + fs_{\text{core}} \cdot Asl_{\text{com,core}}) / Asl_{\text{com}} = 727.0465$$

$$\text{with } Es2 = (Es_{\text{jacket}} \cdot Asl_{\text{com,jacket}} + Es_{\text{core}} \cdot Asl_{\text{com,core}}) / Asl_{\text{com}} = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 937.50$$

$$fyv = 781.25$$

$$suv = 0.032$$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

$$lo/lo_{\text{min}} = lb/ld = 1.00$$

$$suv = 0.4 \cdot esuv_{\text{nominal}} ((5.5), \text{TBDY}) = 0.032$$
 From table 5A.1, TBDY: $esuv_{\text{nominal}} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{\text{nominal}}$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = (fs_{\text{jacket}} \cdot Asl_{\text{mid,jacket}} + fs_{\text{mid}} \cdot Asl_{\text{mid,core}}) / Asl_{\text{mid}} = 781.25$$

$$\text{with } Esv = (Es_{\text{jacket}} \cdot Asl_{\text{mid,jacket}} + Es_{\text{mid}} \cdot Asl_{\text{mid,core}}) / Asl_{\text{mid}} = 200000.00$$

$$1 = Asl_{\text{ten}} / (b \cdot d) \cdot (fs1 / fc) = 0.12378842$$

$$2 = Asl_{\text{com}} / (b \cdot d) \cdot (fs2 / fc) = 0.06860752$$

$$v = Asl_{\text{mid}} / (b \cdot d) \cdot (fsv / fc) = 0.04175429$$
 and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, \text{TBDY}) = 30.00$$

$$cc (5A.5, \text{TBDY}) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = Asl_{\text{ten}} / (b \cdot d) \cdot (fs1 / fc) = 0.15295169$$

$$2 = Asl_{\text{com}} / (b \cdot d) \cdot (fs2 / fc) = 0.08477074$$

$$v = Asl_{\text{mid}} / (b \cdot d) \cdot (fsv / fc) = 0.05159117$$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

---->
 $v < vs,y2$ - LHS eq.(4.5) is not satisfied
 ---->
 $v < vs,c$ - RHS eq.(4.5) is satisfied
 ---->

$$su (4.8) = 0.16206515$$

$$Mu = MRc (4.15) = 7.8817E+008$$

$$u = su (4.1) = 6.0907698E-005$$

 Calculation of ratio lb/ld

 Adequate Lap Length: $lb/ld \geq 1$

 Calculation of $Mu2+$

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 5.6369735E-005$$

$$\mu = 4.6479E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_o(5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.0053097$$

$$\phi_{we} \text{ (5.4c)} = 0.00204688$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $\phi_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.45559$$

$$\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.38519$$

$$\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 872.4558$$

$$fy_1 = 727.0465$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o/l_{o,u,min} = l_b/l_d = 1.00$$

$$s_u1 = 0.4 * e_{s1_nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{s1_nominal} = 0.08$,

For calculation of $e_{s1_nominal}$ and y_1, sh_1, ft_1, 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.

$$\text{with } f_{s1} = (f_{s,jacket} * A_{s,ten,jacket} + f_{s,core} * A_{s,ten,core}) / A_{s,ten} = 727.0465$$

$$\text{with } E_{s1} = (E_{s,jacket} * A_{s,ten,jacket} + E_{s,core} * A_{s,ten,core}) / A_{s,ten} = 200000.00$$

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 882.7854$$

$$fy_2 = 735.6545$$

$$s_u2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$$l_o/l_{o,u,min} = l_b/l_{b,min} = 1.00$$

$$s_u2 = 0.4 * e_{s2_nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{s2_nominal} = 0.08$,

For calculation of $e_{s2_nominal}$ and y_2, sh_2, ft_2, 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.

$$\text{with } f_{s2} = (f_{s,jacket} * A_{s,com,jacket} + f_{s,core} * A_{s,com,core}) / A_{s,com} = 735.6545$$

$$\text{with } E_{s2} = (E_{s,jacket} * A_{s,com,jacket} + E_{s,core} * A_{s,com,core}) / A_{s,com} = 200000.00$$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 937.50$$

$$fy_v = 781.25$$

$$s_uv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$$l_o/l_{o,u,min} = l_b/l_d = 1.00$$

$$s_{uv} = 0.4 * e_{suv_nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{suv_nominal} = 0.08$,

considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY

For calculation of $e_{suv_nominal}$ and y_v, sh_v, ft_v, 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.

$$\text{with } f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 781.25$$

$$\text{with } E_{sv} = (E_{s,jacket} * A_{s,mid,jacket} + E_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 200000.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.06860752$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.12378842$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.04175429$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 30.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.08477074$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.15295169$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.05159117$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.09460844$$

$$Mu = MR_c (4.14) = 4.6479E+008$$

$$u = s_u (4.1) = 5.6369735E-005$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Mu2-

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\mu = 6.0907698E-005$$

$$Mu = 7.8817E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.0053097$$

$$w_e \text{ (5.4c)} = 0.00204688$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.45559$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

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, $n_{s_2} = 2.00$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.38519$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

No stirrups, $n_{s_1} = 2.00$

$$h_1 = 400.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

No stirrups, $n_{s_2} = 2.00$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 882.7854$$

$fy1 = 735.6545$
 $su1 = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/ld = 1.00$
 $su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu1_nominal = 0.08$,
 For calculation of $esu1_nominal$ and $y1, sh1,ft1,fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 735.6545$
 with $Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$
 $y2 = 0.0025$
 $sh2 = 0.008$
 $ft2 = 872.4558$
 $fy2 = 727.0465$
 $su2 = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/lb,min = 1.00$
 $su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ and $y2, sh2,ft2,fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 727.0465$
 with $Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$
 $yv = 0.0025$
 $shv = 0.008$
 $ftv = 937.50$
 $fyv = 781.25$
 $suv = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/ld = 1.00$
 $suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv,ftv,fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 781.25$
 with $Es_v = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.12378842$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.06860752$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429$
 and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.15295169$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.08477074$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < vs,y2$ - LHS eq.(4.5) is not satisfied
 --->
 $v < vs,c$ - RHS eq.(4.5) is satisfied
 --->
 $su (4.8) = 0.16206515$

$$\begin{aligned} \mu &= MRC(4.15) = 7.8817E+008 \\ u &= su(4.1) = 6.0907698E-005 \end{aligned}$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 578810.994$

Calculation of Shear Strength at edge 1, $V_{r1} = 578810.994$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'V_w' is replaced by 'V_w + f*V_f'
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 192813.976$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot Area_jacket + f'_{c_core} \cdot Area_core) / Area_section = 27.76119$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu < 1 = 1.00$
 $\mu = 1.1510E+006$
 $V_u = 9840.634$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 385997.017$
 $V_{s1} = 350811.18$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 35185.838$ is calculated for jacket, with:
 $d_2 = 400.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

Calculation of Shear Strength at edge 2, $V_{r2} = 578810.994$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'V_w' is replaced by 'V_w + f*V_f'
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 192813.976$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot Area_jacket + f'_{c_core} \cdot Area_core) / Area_section = 27.76119$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu < 1 = 1.00$
 $\mu = 1.1510E+006$
 $V_u = 9840.632$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 385997.017$
 $V_{s1} = 350811.18$ is calculated for jacket, with:
 $d = 536.00$

Av = 157079.633
fy = 625.00
s = 150.00

Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
Vs2 = 35185.838 is calculated for jacket, with:

d = 400.00
Av = 100530.965
fy = 525.00
s = 300.00

Vs2 has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $Vs + Vf \leq 750430.726$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjars

Constant Properties

Knowledge Factor, = 0.87

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, $f_s = 1.25 * f_{sm} = 781.25$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 * f_{sm} = 656.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou, min} > 1$)

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = -9.0372119E-015$

EDGE -B-

Shear Force, $V_b = 9.0372119E-015$

BOTH EDGES

Axial Force, $F = -2309.833$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 709.9999$

-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 , $V_e/V_r = 0.55914272$

Member Controlled by Flexure ($V_e/V_r < 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n / 2 = 218168.257$

with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 3.2725E+008$

$M_{u1+} = 3.2725E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$M_{u1-} = 3.2725E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 3.2725E+008$

$M_{u2+} = 3.2725E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

$M_{u2-} = 3.2725E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

and

$\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$

with

$V_1 = -9.0372119E-015$, is the shear force acting at edge 1 for the the static loading combination

$V_2 = 9.0372119E-015$, is the shear force acting at edge 2 for the the static loading combination

Calculation of M_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$\phi_u = 0.00010507$

$M_u = 3.2725E+008$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.0003219$

$N = 2309.833$

$f_c = 30.00$

ϕ_c (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_c, \phi_{cc}) = 0.0053097$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\phi_u = 0.0053097$

w_e (5.4c) = 0.00204688

a_{se} ((5.4d), TBDY) = $(a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int}) / A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o_1} = 340.00$

$h_{o_1} = 610.00$

$b_{i2_1} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o_2} = 192.00$

$h_{o_2} = 492.00$

$b_{i2_2} = 557856.00$

$$psh_{min} * Fy_{we} = \text{Min}(psh_x * Fy_{we}, psh_y * Fy_{we}) = 1.38519$$

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)

$$psh_x * Fy_{we} = psh_1 * Fy_{we1} + ps_2 * Fy_{we2} = 2.45559$$

$$ps_1 \text{ (external)} = (Ash_1 * h_1 / s_1) / A_{sec} = 0.00261799$$

$$Ash_1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h_1 = 670.00$$

$$ps_2 \text{ (internal)} = (Ash_2 * h_2 / s_2) / A_{sec} = 0.00062519$$

$$Ash_2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h_2 = 500.00$$

$$psh_y * Fy_{we} = psh_1 * Fy_{we1} + ps_2 * Fy_{we2} = 1.38519$$

$$ps_1 \text{ (external)} = (Ash_1 * h_1 / s_1) / A_{sec} = 0.00156298$$

$$Ash_1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h_1 = 400.00$$

$$ps_2 \text{ (internal)} = (Ash_2 * h_2 / s_2) / A_{sec} = 0.00025008$$

$$Ash_2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$fy_{we1} = 781.25$$

$$fy_{we2} = 656.25$$

$$f_{ce} = 30.00$$

From ((5.A5), TBDY), TBDY: $cc = 0.002$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 886.8103$$

$$fy_1 = 739.0086$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$lo/lo_{min} = lb/lb_{min} = 1.00$$

$$su_1 = 0.4 * esu_{1_nominal} \text{ ((5.5), TBDY)} = 0.032$$

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 $\text{Min}(1, 1.25 * (lb/lb_{min})^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 739.0086$$

$$\text{with } Es_1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$$

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 886.8103$$

$$fy_2 = 739.0086$$

$$su_2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$lo/lo_{min} = lb/lb_{min} = 1.00$$

$$su_2 = 0.4 * esu_{2_nominal} \text{ ((5.5), TBDY)} = 0.032$$

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 $\text{Min}(1, 1.25 * (lb/lb_{min})^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 739.0086$$

$$\text{with } Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 895.9746$$

$$f_{yv} = 746.6455$$

$$s_{uv} = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_o/l_{ou,min} = l_b/l_d = 1.00$$

$$s_{uv} = 0.4 * e_{suv,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{suv,nominal} = 0.08$,

considering characteristic value $f_{sv} = f_{sv}/1.2$, 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.

γ_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.

$$\text{with } f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 746.6455$$

$$\text{with } E_{sv} = (E_{s,jacket} * A_{s,mid,jacket} + E_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 200000.00$$

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.09382814$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.09382814$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.05785932$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 30.00$$

$$c_c (5A.5, TBDY) = 0.002$$

c = confinement factor = 1.00

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.11251192$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.11251192$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.06938071$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

---->

$$s_u (4.9) = 0.1468828$$

$$\mu_u = M_{Rc} (4.14) = 3.2725E+008$$

$$u = s_u (4.1) = 0.00010507$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of μ_u 1-

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 0.00010507$$

$$\mu_u = 3.2725E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_o (5A.5, TBDY) = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.0053097$$

$$w_e (5.4c) = 0.00204688$$

$$\text{ase} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.38519

Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.45559
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.38519
ps1 (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 = 781.25
fywe2 = 656.25
fce = 30.00

From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00

y1 = 0.0025
sh1 = 0.008
ft1 = 886.8103
fy1 = 739.0086
su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by 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 = 739.0086

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025
sh2 = 0.008
ft2 = 886.8103
fy2 = 739.0086
su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb,min)^ 2/3), from 10.3.5, ASCE 41-17.

with $f_{s2} = (f_{s,jacket} \cdot A_{s,com,jacket} + f_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 739.0086$
 with $E_{s2} = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 200000.00$
 $y_v = 0.0025$
 $sh_v = 0.008$
 $ft_v = 895.9746$
 $fy_v = 746.6455$
 $suv = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 1.00$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 746.6455$
 with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.09382814$
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.09382814$
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.05785932$

and confined core properties:

$b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.11251192$
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.11251192$
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.06938071$

Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

$su (4.9) = 0.1468828$
 $Mu = MRc (4.14) = 3.2725E+008$
 $u = su (4.1) = 0.00010507$

 Calculation of ratio l_b/l_d

 Adequate Lap Length: $l_b/l_d \geq 1$

 Calculation of Mu_{2+}

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 0.00010507$
 $Mu = 3.2725E+008$

 with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.0003219$
 $N = 2309.833$
 $f_c = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0053097$

w_e (5.4c) = 0.00204688
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$

$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.38519$

Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.45559$
 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, $n_{s_2} = 2.00$
 $h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.38519$
 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, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$A_{sec} = 268000.00$

$s_1 = 150.00$

$s_2 = 300.00$

$f_{ywe1} = 781.25$

$f_{ywe2} = 656.25$

$f_{ce} = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$

$c =$ confinement factor = 1.00

$y_1 = 0.0025$

$sh_1 = 0.008$

$ft_1 = 886.8103$

$fy_1 = 739.0086$

$su_1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$l_o / l_{ou, \min} = l_b / l_d = 1.00$

$su_1 = 0.4 * esu_{1, \text{nominal}} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu_{1, \text{nominal}} = 0.08$,

For calculation of $esu_{1, \text{nominal}}$ and y_1, sh_1, ft_1, fy_1 , it is considered characteristic value $fs_1 = fs_1 / 1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 739.0086$

with $Es_1 = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$

$y_2 = 0.0025$

$sh_2 = 0.008$

$ft_2 = 886.8103$

$fy_2 = 739.0086$

$su_2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$l_o / l_{ou, \min} = l_b / l_{b, \min} = 1.00$

$$su_2 = 0.4 * esu_{2_nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esu_{2_nominal} = 0.08$,

For calculation of $esu_{2_nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered characteristic value $fs_2 = fs_2/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_2 = (fs_{jacket} * Asl_{,com,jacket} + fs_{core} * Asl_{,com,core}) / Asl_{,com} = 739.0086$$

$$\text{with } Es_2 = (Es_{jacket} * Asl_{,com,jacket} + Es_{core} * Asl_{,com,core}) / Asl_{,com} = 200000.00$$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 895.9746$$

$$fy_v = 746.6455$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$lo/lo_{u,min} = lb/ld = 1.00$$

$$suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,

considering characteristic value $fs_v = fs_v/1.2$, 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 $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_v = (fs_{jacket} * Asl_{,mid,jacket} + fs_{mid} * Asl_{,mid,core}) / Asl_{,mid} = 746.6455$$

$$\text{with } Es_v = (Es_{jacket} * Asl_{,mid,jacket} + Es_{mid} * Asl_{,mid,core}) / Asl_{,mid} = 200000.00$$

$$1 = Asl_{,ten} / (b * d) * (fs_1 / fc) = 0.09382814$$

$$2 = Asl_{,com} / (b * d) * (fs_2 / fc) = 0.09382814$$

$$v = Asl_{,mid} / (b * d) * (fs_v / fc) = 0.05785932$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 30.00$$

$$cc (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = Asl_{,ten} / (b * d) * (fs_1 / fc) = 0.11251192$$

$$2 = Asl_{,com} / (b * d) * (fs_2 / fc) = 0.11251192$$

$$v = Asl_{,mid} / (b * d) * (fs_v / fc) = 0.06938071$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

--->

$$su (4.9) = 0.1468828$$

$$Mu = MRc (4.14) = 3.2725E+008$$

$$u = su (4.1) = 0.00010507$$

Calculation of ratio lb/ld

Adequate Lap Length: $lb/ld \geq 1$

Calculation of Mu_2 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 0.00010507$$

$$Mu = 3.2725E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0053097$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.0053097$$

$$w_e \text{ (5.4c)} = 0.00204688$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.45559$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.38519$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 886.8103$$

$$fy_1 = 739.0086$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o / l_{ou, \min} = l_b / l_d = 1.00$$

$$su_1 = 0.4 * e_{su1_nominal} \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } e_{su1_nominal} = 0.08,$$

For calculation of $e_{su1_nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered characteristic value $fs_1 = fs_1 / 1.2$, from table 5.1, TBDY.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b / l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 739.0086$$

$$\text{with } E_{s1} = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$$

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 886.8103$$

$$fy_2 = 739.0086$$

$$su_2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lo_{u,min} = lb/lb_{u,min} = 1.00$$

$$su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,

For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $fs_2 = fs_2/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 739.0086$$

$$\text{with } Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 895.9746$$

$$fyv = 746.6455$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lo_{u,min} = lb/ld = 1.00$$

$$suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$$

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 yv, shv, ftv, fyv , 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.

$$\text{with } fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 746.6455$$

$$\text{with } Esv = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$$

$$1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.09382814$$

$$2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.09382814$$

$$v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.05785932$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 30.00$$

$$cc (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.11251192$$

$$2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.11251192$$

$$v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.06938071$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

---->

$$su (4.9) = 0.1468828$$

$$\mu = MRc (4.14) = 3.2725E+008$$

$$u = su (4.1) = 0.00010507$$

Calculation of ratio lb/ld

Adequate Lap Length: $lb/ld \geq 1$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 390183.487$

Calculation of Shear Strength at edge 1, $V_{r1} = 390183.487$

$$V_{r1} = V_n ((22.5.1.1), ACI 318-14)$$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f * V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$
 $= 1$ (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot Area_jacket + f'_{c_core} \cdot Area_core) / Area_section = 27.76119$, but $f'_c^{0.5} < = 8.3$ MPa (22.5.3.1, ACI 318-14)
 $pw = A_s / (bw \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $bw = 670.00$
 $d = 320.00$
 $V_u \cdot d / \mu < 1 = 0.00$
 $\mu = 6.8565666E-012$
 $V_u = 9.0372119E-015$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:
 $d_2 = 160.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f < = 750430.726$

Calculation of Shear Strength at edge 2, $V_{r2} = 390183.487$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$
 $= 1$ (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot Area_jacket + f'_{c_core} \cdot Area_core) / Area_section = 27.76119$, but $f'_c^{0.5} < = 8.3$ MPa (22.5.3.1, ACI 318-14)
 $pw = A_s / (bw \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $bw = 670.00$
 $d = 320.00$
 $V_u \cdot d / \mu < 1 = 0.00$
 $\mu = 2.0256286E-011$
 $V_u = 9.0372119E-015$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:
 $d = 160.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f < = 750430.726$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3
Integration Section: (b)
Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$
New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$
Concrete Elasticity, $E_c = 25742.96$
Steel Elasticity, $E_s = 200000.00$
Existing Column
Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$
Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$
Concrete Elasticity, $E_c = 23025.204$
Steel Elasticity, $E_s = 200000.00$
External Height, $H = 670.00$
External Width, $W = 400.00$
Internal Height, $H = 500.00$
Internal Width, $W = 200.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_b/d >= 1$)
No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 4.4683392E-011$
Shear Force, $V_2 = -2.4489115E-014$
Shear Force, $V_3 = 18514.856$
Axial Force, $F = -9608.729$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl} = 709.9999$
-Compression: $A_{slc} = 1668.186$
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, $DbL = 15.20$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_{,R} = \gamma * u = 0.02097574$
 $u = \gamma + \rho = 0.02411005$

- Calculation of γ -

$y = (M_y * L_s / 3) / E_{eff} = 0.00411005$ ((4.29), Biskinis Phd))
My = 2.1288E+008
Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 2.5898E+013$

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

 $y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 1.0755102E-005$
with $f_y = 625.00$
d = 357.00
y = 0.22825315
A = 0.01001045
B = 0.0056379
with $p_t = 0.00380895$
pc = 0.00380895
pv = 0.00232477
N = 9608.729
b = 670.00
" = 0.12044818
 $y_{comp} = 2.5830452E-005$
with $f_c = 27.76119$
Ec = 25742.96
y = 0.22747572
A = 0.00984691
B = 0.00557012
with Es = 200000.00

Calculation of ratio lb/d

Adequate Lap Length: $lb/d \geq 1$

- Calculation of p -

From table 10-7: $p = 0.02$

with:

- Condition i occurred

Beam controlled by flexure: $V_p/V_o \leq 1$

shear control ratio $V_p/V_o = 0.55914272$

- Transverse Reinforcement: NC

- Stirrup Spacing > d/3

- Low ductility demand, $\lambda / y < 2$ (table 10-6, ASCE 41-17)

= -4.4850417E-023

- Stirrup Spacing $\leq d/2$

d = d_external = 357.00

s = s_external = 150.00

- Strength provided by hoops $V_s < 3/4 * \text{design Shear}$

$V_s = 237588.18$, already given in calculation of shear control ratio

design Shear = 2.4489115E-014

- (-)/ bal = -0.33327376

= $A_{st} / (b_w * d) = 0.00296835$

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 = 0.01202003

$f_c = (f_{c_jacket} * \text{Area}_{jacket} + f_{c_core} * \text{Area}_{core}) / \text{section_area} = 27.76119$

$f_y = f_{y_jacket_bars} = 625.00$

From 10.2.7.3, ACI 318-11: $\lambda = 0.65$

From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + y) = 0.48979592$

y = 0.003125

- $V / (b_w * d * f_c^{0.5}) = 2.3400990E-019$, NOTE: units in lb & in

bw = 670.00

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1
At local axis: 3
Integration Section: (b)
