

# Detailed Member Calculations

**Units: N&mm**

**Regulation: ASCE 41-17**

## Calculation No. 1

beam B1, Floor 1

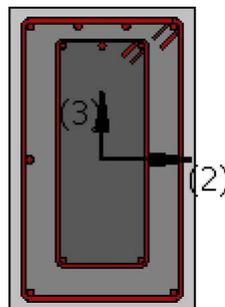
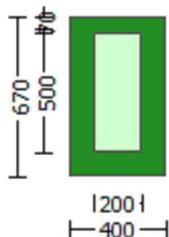
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity  $V_{Rd}$

Edge: Start

Local Axis: (2)



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

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

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

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

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$

Concrete Elasticity,  $E_c = 26999.444$   
Steel Elasticity,  $E_s = 200000.00$   
Existing Column  
New material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$   
New material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$   
Concrete Elasticity,  $E_c = 26999.444$   
Steel Elasticity,  $E_s = 200000.00$   
External Height,  $H = 670.00$   
External Width,  $W = 400.00$   
Internal Height,  $H = 500.00$   
Internal Width,  $W = 200.00$   
Cover Thickness,  $c = 25.00$   
Element Length,  $L = 3000.00$   
Primary Member  
Smooth Bars  
Ductile Steel  
With Detailing for Earthquake Resistance (including stirrups 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

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Stepwise Properties  
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EDGE -A-  
Bending Moment,  $M_a = -1.5808831E-010$   
Shear Force,  $V_a = -8.4049242E-014$   
EDGE -B-  
Bending Moment,  $M_b = -9.4153455E-011$   
Shear Force,  $V_b = 8.4049242E-014$   
BOTH EDGES  
Axial Force,  $F = -4363.489$   
Longitudinal Reinforcement Area Distribution (in 2 divisions)  
-Tension:  $A_{st} = 709.9999$   
-Compression:  $A_{sc} = 1668.186$   
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $A_{st,ten} = 911.0619$   
-Compression:  $A_{sc,com} = 911.0619$   
-Middle:  $A_{st,mid} = 556.0619$   
Mean Diameter of Tension Reinforcement,  $Db_{L,ten} = 15.20$

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

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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).

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From Table (22.5.5.1), ACI 318-14:  $V_c = 171520.00$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot Area_{jacket} + f'_{c\_core} \cdot Area_{core}) / Area_{section} = 25.00$ , but  $f_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 1.5808831E-010$   
 $V_u = 8.4049242E-014$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 167551.608$   
 $V_{s1} = 167551.608$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 500.00$   
 $s = 150.00$

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

Vs2 = 0.00 is calculated for core, with:

$d = 160.00$

$A_v = 100530.965$

$f_y = 500.00$

$s = 300.00$

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

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

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

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

At local axis: 2

Integration Section: (a)

## Calculation No. 2

beam B1, Floor 1

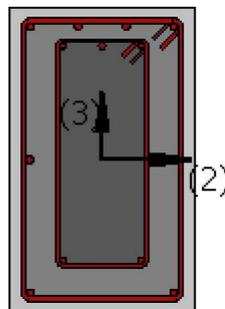
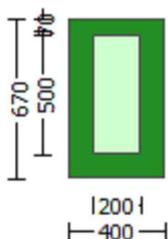
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (  $\theta$  )

Edge: Start

Local Axis: (2)



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

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

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Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
#####
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
#####
External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03245
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = 9840.633
EDGE -B-
Shear Force, Vb = 9840.633
BOTH EDGES
Axial Force, F = -2237.255
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 709.9999
-Compression: Aslc = 1668.186
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 709.9999
-Compression: Asl,com = 1266.062
-Middle: Asl,mid = 402.1239
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Calculation of Shear Capacity ratio , Ve/Vr = 0.90705729
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 = 506319.489
with
Mpr1 = Max(Mu1+ , Mu1-) = 7.4472E+008
Mu1+ = 4.3734E+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- = 7.4472E+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-) = 7.4472E+008
Mu2+ = 4.3734E+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- = 7.4472E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination
and
± wu*ln = (|V1| + |V2|)/2
with

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

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Calculation of Mu1+  
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Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:

$$\mu = 5.6088283E-005$$

$$\text{Mu} = 4.3734E+008$$

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with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear\_factor} * \text{Max}(c_u, c_c) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00650345$$

$$w_e \text{ (5.4c)} = 0.00563796$$

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

$$a_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

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

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

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

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

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$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$f_{t1} = 833.34$$

$$f_{y1} = 694.45$$

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

with fs1 = (fs,jacket\*Asl,ten,jacket + fs,core\*Asl,ten,core)/Asl,ten = 694.45

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

y2 = 0.0025

sh2 = 0.008

ft2 = 833.34

fy2 = 694.45

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 = 694.45

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

yv = 0.0025

shv = 0.008

ftv = 833.34

fyv = 694.45

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

with fsv = (fs,jacket\*Asl,mid,jacket + fs,mid\*Asl,mid,core)/Asl,mid = 694.45

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

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.05957415

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.10623177

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.03374111

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07073

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.0736092

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.13125889

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.04169017

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.09006517

Mu = MRc (4.14) = 4.3734E+008

u = su (4.1) = 5.6088283E-005

Calculation of ratio  $l_b/d$

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

Calculation of  $\mu_1$

Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:

$$\mu = 5.9367084E-005$$

$$\mu_1 = 7.4472E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu_c: \mu_c^* = \text{shear\_factor} * \text{Max}(\mu_c, \mu_{cc}) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu_c = 0.00650345$$

$$\mu_{we} \text{ (5.4c)} = 0.00563796$$

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

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

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

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

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

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

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 833.34$$

$$fy1 = 694.45$$

$$su1 = 0.032$$

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.

$$\text{with } fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45$$

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

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 833.34$$

$$fy2 = 694.45$$

$$su2 = 0.032$$

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.

$$\text{with } fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45$$

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

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 833.34$$

$$fyv = 694.45$$

$$suv = 0.032$$

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.

$$\text{with } fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45$$

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

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.10623177$$

$$2 = Asl,com/(b*d)*(fs2/fc) = 0.05957415$$

$$v = Asl,mid/(b*d)*(fsv/fc) = 0.03374111$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 34.07073$$

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

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

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.13125889$$

$$2 = Asl,com/(b*d)*(fs2/fc) = 0.0736092$$

$$v = Asl,mid/(b*d)*(fsv/fc) = 0.04169017$$

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

--->

$$s_u(4.8) = 0.1403202$$

$$M_u = M_{Rc}(4.15) = 7.4472E+008$$

$$u = s_u(4.1) = 5.9367084E-005$$

-----  
Calculation of ratio  $l_b/l_d$

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

-----  
Calculation of  $M_u/2+$

-----  
Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

$$u = 5.6088283E-005$$

$$M_u = 4.3734E+008$$

-----  
with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00650345$$

$$\phi_{we}(5.4c) = 0.00563796$$

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

$$a_{se1} = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i21} = 975400.00$$

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

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i22} = 557856.00$$

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

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

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

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

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

-----  
$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$fy_{we2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

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.

$$\text{with } fs_1 = (fs_{\text{jacket}} * Asl, \text{ten, jacket} + fs_{\text{core}} * Asl, \text{ten, core}) / Asl, \text{ten} = 694.45$$

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

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 833.34$$

$$fy_2 = 694.45$$

$$su_2 = 0.032$$

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.

$$\text{with } fs_2 = (fs_{\text{jacket}} * Asl, \text{com, jacket} + fs_{\text{core}} * Asl, \text{com, core}) / Asl, \text{com} = 694.45$$

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

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 833.34$$

$$fy_v = 694.45$$

$$su_v = 0.032$$

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.

$$\text{with } fs_v = (fs_{\text{jacket}} * Asl, \text{mid, jacket} + fs_{\text{mid}} * Asl, \text{mid, core}) / Asl, \text{mid} = 694.45$$

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

$$1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.05957415$$

$$2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.10623177$$

$$v = Asl, \text{mid} / (b * d) * (fs_v / f_c) = 0.03374111$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, \text{TBDY}) = 34.07073$$

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

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

$$1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.0736092$$

$$2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.13125889$$

$$v = Asl, \text{mid} / (b * d) * (fs_v / f_c) = 0.04169017$$

Case/Assumption: Unconfinedsd full section - Steel rupture

satisfies Eq. (4.3)

--->

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

--->

$$s_u(4.9) = 0.09006517$$

$$M_u = M_{Rc}(4.14) = 4.3734E+008$$

$$u = s_u(4.1) = 5.6088283E-005$$

Calculation of ratio  $l_b/l_d$

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

Calculation of  $\mu_2$ -

Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:

$$u = 5.9367084E-005$$

$$M_u = 7.4472E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear\_factor} * \text{Max}(\mu_c, \mu_{cc}) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu_c = 0.00650345$$

$$\mu_{cc}(5.4c) = 0.00563796$$

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

$$a_{se1} = 0.14776895$$

$$b_{o,1} = 340.00$$

$$h_{o,1} = 610.00$$

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

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

$$b_{o,2} = 192.00$$

$$h_{o,2} = 492.00$$

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

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

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

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

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

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

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

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

y1 = 0.0025  
sh1 = 0.008  
ft1 = 833.34  
fy1 = 694.45  
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  $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$ , from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket\*Asl,ten,jacket + fs,core\*Asl,ten,core)/Asl,ten = 694.45

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

y2 = 0.0025  
sh2 = 0.008  
ft2 = 833.34  
fy2 = 694.45  
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 = 694.45

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

yv = 0.0025  
shv = 0.008  
ftv = 833.34  
fyv = 694.45  
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  $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$ , from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket\*Asl,mid,jacket + fs,mid\*Asl,mid,core)/Asl,mid = 694.45

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

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.10623177

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.05957415

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.03374111

and confined core properties:

b = 340.00  
d = 597.00  
d' = 13.00

fcc (5A.2, TBDY) = 34.07073

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.13125889

$$2 = A_{sl,com}/(b*d)*(f_s2/f_c) = 0.0736092$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.04169017$$

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) = 0.1403202

$$\mu_u = M_{Rc} \text{ (4.15)} = 7.4472E+008$$

$$u = s_u \text{ (4.1)} = 5.9367084E-005$$

-----  
Calculation of ratio  $l_b/l_d$

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

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

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

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

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

-----  
From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
= 1 (normal-weight concrete)

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

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

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

$$b_w = 400.00$$

$$d = 536.00$$

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

$$\mu_u = 1.0197E+006$$

$$V_u = 9840.633$$

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

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

$$d = 536.00$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

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

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

$$d_2 = 400.00$$

$$A_v = 100530.965$$

$$f_y = 555.56$$

$$s = 300.00$$

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

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

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

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

-----  
Calculation of Shear Strength at edge 2,  $V_{r2} = 558200.119$

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

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

-----  
From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
= 1 (normal-weight concrete)

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

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

$As$  (tension reinf.) = 709.9999

$bw = 400.00$

$d = 536.00$

$Vu*d/Mu < 1 = 1.00$

$Mu = 1.0197E+006$

$Vu = 9840.633$

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

$Vs1 = 311834.654$  is calculated for jacket, with:

$d = 536.00$

$Av = 157079.633$

$fy = 555.56$

$s = 150.00$

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

$Vs2 = 37233.989$  is calculated for jacket, with:

$d = 400.00$

$Av = 100530.965$

$fy = 555.56$

$s = 300.00$

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

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

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

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

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

At local axis: 3  
-----

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

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties  
-----

Knowledge Factor, = 1.00

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $Ec = 26999.444$

Steel Elasticity,  $Es = 200000.00$

Existing Column

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

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

Concrete Elasticity,  $Ec = 26999.444$

Steel Elasticity,  $Es = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

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

Jacket

New material: Steel Strength,  $fs = 1.25*fsm = 694.45$

Existing Column

New material: Steel Strength,  $fs = 1.25*fsm = 694.45$

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.03245

Element Length,  $L = 3000.00$

Primary Member

Smooth Bars

Ductile Steel  
With Detailing for Earthquake Resistance (including stirrups closed at 135°)  
Longitudinal Bars With Ends Lapped Starting at the End Sections  
Adequate Lap Length ( $l_o/l_{ou, \min} >= 1$ )  
No FRP Wrapping

-----  
Stepwise Properties  
-----

At local axis: 2  
EDGE -A-  
Shear Force,  $V_a = -6.9721474E-015$   
EDGE -B-  
Shear Force,  $V_b = 6.9721474E-015$   
BOTH EDGES  
Axial Force,  $F = -2237.255$   
Longitudinal Reinforcement Area Distribution (in 2 divisions)  
-Tension:  $A_{st} = 709.9999$   
-Compression:  $A_{sc} = 1668.186$   
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $A_{st, \text{ten}} = 911.0619$   
-Compression:  $A_{sc, \text{com}} = 911.0619$   
-Middle:  $A_{sc, \text{mid}} = 556.0619$   
-----  
-----

Calculation of Shear Capacity ratio,  $V_e/V_r = 0.53480887$   
Member Controlled by Flexure ( $V_e/V_r < 1$ )  
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n / 2 = 204955.561$   
with  
 $M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 3.0743E+008$   
 $M_{u1+} = 3.0743E+008$ , 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  
 $M_{u1-} = 3.0743E+008$ , 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  
 $M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 3.0743E+008$   
 $M_{u2+} = 3.0743E+008$ , 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  
 $M_{u2-} = 3.0743E+008$ , 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  
 $V_1 = -6.9721474E-015$ , is the shear force acting at edge 1 for the the static loading combination  
 $V_2 = 6.9721474E-015$ , is the shear force acting at edge 2 for the the static loading combination

-----  
Calculation of  $M_{u1+}$   
-----

-----  
Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:  
 $\phi_u = 0.00010406$   
 $M_u = 3.0743E+008$   
-----

with full section properties:

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

$f_c = 33.00$

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

Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} * \text{Max}(\phi_c, \phi_u) = 0.00650345$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $\phi_u = 0.00650345$

we (5.4c) = 0.00563796  
ase ((5.4d), TBDY) = (ase1\*Aext+ase2\*Aint)/Asec = 0.14776895  
ase1 = 0.14776895  
bo\_1 = 340.00  
ho\_1 = 610.00  
bi2\_1 = 975400.00  
ase2 = Max(ase1,ase2) = 0.14776895  
bo\_2 = 192.00  
ho\_2 = 492.00  
bi2\_2 = 557856.00  
psh,min\*Fywe = Min(psh,x\*Fywe , psh,y\*Fywe) = 1.25908

psh\_x\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 2.25223  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00261799  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 670.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00062519  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00156298  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 400.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00025008  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 200.00

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

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

y1 = 0.0025  
sh1 = 0.008  
ft1 = 833.34  
fy1 = 694.45  
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 = (fsjacket\*Asl,ten,jacket + fs,core\*Asl,ten,core)/Asl,ten = 694.45

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

y2 = 0.0025  
sh2 = 0.008  
ft2 = 833.34  
fy2 = 694.45  
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  $es_{2,nominal}$  and  $y_2$ ,  $sh_2, ft_2, fy_2$ , it is considered characteristic value  $fs_2 = fs_2/1.2$ , from table 5.1, TBDY.

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

with  $fs_2 = (fs_{jacket} \cdot Asl_{,com,jacket} + fs_{core} \cdot Asl_{,com,core}) / Asl_{,com} = 694.45$

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

$y_v = 0.0025$

$sh_v = 0.008$

$ft_v = 833.34$

$fy_v = 694.45$

$suv = 0.032$

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

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

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

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

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

For calculation of  $es_{uv,nominal}$  and  $y_v$ ,  $sh_v, ft_v, fy_v$ , it is considered characteristic value  $fs_v = fs_v/1.2$ , from table 5.1, TBDY.

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

with  $fs_v = (fs_{jacket} \cdot Asl_{,mid,jacket} + fs_{mid} \cdot Asl_{,mid,core}) / Asl_{,mid} = 694.45$

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

$1 = Asl_{,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.08015524$

$2 = Asl_{,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.08015524$

$v = Asl_{,mid} / (b \cdot d) \cdot (fs_v / fc) = 0.04892233$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

$fcc$  (5A.2, TBDY) = 34.07073

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

$c$  = confinement factor = 1.03245

$1 = Asl_{,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.09611636$

$2 = Asl_{,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.09611636$

$v = Asl_{,mid} / (b \cdot d) \cdot (fs_v / fc) = 0.05866412$

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) = 0.13857861

$Mu = MRc$  (4.14) = 3.0743E+008

$u = su$  (4.1) = 0.00010406

-----  
Calculation of ratio  $lb/d$

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

-----  
Calculation of  $Mu_1$ -

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

$u = 0.00010406$

$Mu = 3.0743E+008$

-----  
with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$fc = 33.00$

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

Final value of  $cu$ :  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00650345$   
 $we$  (5.4c) = 0.00563796  
 $ase$  ((5.4d), TBDY) =  $(ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo_1 = 340.00$   
 $ho_1 = 610.00$   
 $bi2_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo_2 = 192.00$   
 $ho_2 = 492.00$   
 $bi2_2 = 557856.00$   
 $psh_{min} * Fy_{we} = \text{Min}(psh_x * Fy_{we}, psh_y * Fy_{we}) = 1.25908$

-----  
 $psh_x * Fy_{we} = psh1 * Fy_{we1} + ps2 * Fy_{we2} = 2.25223$   
 $ps1$  (external) =  $(Ash1 * h1 / s1) / A_{sec} = 0.00261799$   
 $Ash1 = Astir_1 * ns_1 = 157.0796$   
 No stirups,  $ns_1 = 2.00$   
 $h1 = 670.00$   
 $ps2$  (internal) =  $(Ash2 * h2 / s2) / A_{sec} = 0.00062519$   
 $Ash2 = Astir_2 * ns_2 = 100.531$   
 No stirups,  $ns_2 = 2.00$   
 $h2 = 500.00$

-----  
 $psh_y * Fy_{we} = psh1 * Fy_{we1} + ps2 * Fy_{we2} = 1.25908$   
 $ps1$  (external) =  $(Ash1 * h1 / s1) / A_{sec} = 0.00156298$   
 $Ash1 = Astir_1 * ns_1 = 157.0796$   
 No stirups,  $ns_1 = 2.00$   
 $h1 = 400.00$   
 $ps2$  (internal) =  $(Ash2 * h2 / s2) / A_{sec} = 0.00025008$   
 $Ash2 = Astir_2 * ns_2 = 100.531$   
 No stirups,  $ns_2 = 2.00$   
 $h2 = 200.00$

-----  
 $A_{sec} = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fy_{we1} = 694.45$   
 $fy_{we2} = 694.45$   
 $f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY:  $cc = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$

$y1 = 0.0025$   
 $sh1 = 0.008$   
 $ft1 = 833.34$   
 $fy1 = 694.45$   
 $su1 = 0.032$

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.

with  $fs1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 694.45$

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

$y2 = 0.0025$   
 $sh2 = 0.008$   
 $ft2 = 833.34$   
 $fy2 = 694.45$   
 $su2 = 0.032$

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

$$l_0/l_{0u,min} = l_b/l_{b,min} = 1.00$$

$$s_u2 = 0.4 * e_{su2,nominal} ((5.5), TBDY) = 0.032$$

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.

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

$$\text{with } f_{s2} = (f_{s,jacket} * A_{s1,com,jacket} + f_{s,core} * A_{s1,com,core}) / A_{s1,com} = 694.45$$

$$\text{with } E_{s2} = (E_{s,jacket} * A_{s1,com,jacket} + E_{s,core} * A_{s1,com,core}) / A_{s1,com} = 200000.00$$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 833.34$$

$$fy_v = 694.45$$

$$s_{uv} = 0.032$$

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

$$l_0/l_{0u,min} = l_b/l_d = 1.00$$

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

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

$$\text{with } f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 694.45$$

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

$$1 = A_{s1,ten} / (b * d) * (f_{s1} / f_c) = 0.08015524$$

$$2 = A_{s1,com} / (b * d) * (f_{s2} / f_c) = 0.08015524$$

$$v = A_{s1,mid} / (b * d) * (f_{sv} / f_c) = 0.04892233$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 34.07073$$

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

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

$$1 = A_{s1,ten} / (b * d) * (f_{s1} / f_c) = 0.09611636$$

$$2 = A_{s1,com} / (b * d) * (f_{s2} / f_c) = 0.09611636$$

$$v = A_{s1,mid} / (b * d) * (f_{sv} / f_c) = 0.05866412$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

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

---->

$$s_u (4.9) = 0.13857861$$

$$\mu_u = M_{Rc} (4.14) = 3.0743E+008$$

$$u = s_u (4.1) = 0.00010406$$

-----  
Calculation of ratio  $l_b/l_d$

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

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

-----  
Calculation of ultimate curvature  $\mu_u$  according to 4.1, Biskinis/Fardis 2013:

$$u = 0.00010406$$

$$\mu_u = 3.0743E+008$$

-----  
with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$N = 2237.255$   
 $fc = 33.00$   
 $co (5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = shear\_factor * Max(cu, cc) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00650345$   
 $we (5.4c) = 0.00563796$   
 $ase ((5.4d), TBDY) = (ase1 * Aext + ase2 * Aint) / Asec = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo\_1 = 340.00$   
 $ho\_1 = 610.00$   
 $bi2\_1 = 975400.00$   
 $ase2 = Max(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$   
 $psh, min * Fywe = Min(psh, x * Fywe, psh, y * Fywe) = 1.25908$

$psh, x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 2.25223$   
 $ps1 (external) = (Ash1 * h1 / s1) / Asec = 0.00261799$   
 $Ash1 = Astir\_1 * ns\_1 = 157.0796$   
 No stirups,  $ns\_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 (internal) = (Ash2 * h2 / s2) / Asec = 0.00062519$   
 $Ash2 = Astir\_2 * ns\_2 = 100.531$   
 No stirups,  $ns\_2 = 2.00$   
 $h2 = 500.00$

$psh, y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.25908$   
 $ps1 (external) = (Ash1 * h1 / s1) / Asec = 0.00156298$   
 $Ash1 = Astir\_1 * ns\_1 = 157.0796$   
 No stirups,  $ns\_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 (internal) = (Ash2 * h2 / s2) / Asec = 0.00025008$   
 $Ash2 = Astir\_2 * ns\_2 = 100.531$   
 No stirups,  $ns\_2 = 2.00$   
 $h2 = 200.00$

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

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

$y1 = 0.0025$   
 $sh1 = 0.008$   
 $ft1 = 833.34$   
 $fy1 = 694.45$   
 $su1 = 0.032$

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  $fs1 = (fs, jacket * Asl, ten, jacket + fs, core * Asl, ten, core) / Asl, ten = 694.45$

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

$y2 = 0.0025$   
 $sh2 = 0.008$   
 $ft2 = 833.34$   
 $fy2 = 694.45$   
 $su2 = 0.032$

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

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

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

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

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

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

$$\text{with } f_{s_2} = (f_{s,jacket} * A_{s_l,com,jacket} + f_{s,core} * A_{s_l,com,core}) / A_{s_l,com} = 694.45$$

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

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 833.34$$

$$fy_v = 694.45$$

$$s_{u_v} = 0.032$$

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

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

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

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

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

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

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

$$\text{with } f_{s_v} = (f_{s,jacket} * A_{s_l,mid,jacket} + f_{s,mid} * A_{s_l,mid,core}) / A_{s_l,mid} = 694.45$$

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

$$1 = A_{s_l,ten} / (b * d) * (f_{s_1} / f_c) = 0.08015524$$

$$2 = A_{s_l,com} / (b * d) * (f_{s_2} / f_c) = 0.08015524$$

$$v = A_{s_l,mid} / (b * d) * (f_{s_v} / f_c) = 0.04892233$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 34.07073$$

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

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

$$1 = A_{s_l,ten} / (b * d) * (f_{s_1} / f_c) = 0.09611636$$

$$2 = A_{s_l,com} / (b * d) * (f_{s_2} / f_c) = 0.09611636$$

$$v = A_{s_l,mid} / (b * d) * (f_{s_v} / f_c) = 0.05866412$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

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

--->

$$s_u (4.9) = 0.13857861$$

$$\mu_u = M_{Rc} (4.14) = 3.0743E+008$$

$$u = s_u (4.1) = 0.00010406$$

-----  
Calculation of ratio  $l_b/l_d$

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

-----  
Calculation of  $\mu_u$ -  
-----  
-----

-----  
Calculation of ultimate curvature  $\mu_u$  according to 4.1, Biskinis/Fardis 2013:

$$u = 0.00010406$$

$$\mu_u = 3.0743E+008$$

-----  
with full section properties:

$$b = 670.00$$

$d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $fc = 33.00$   
 $co (5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = shear\_factor * Max(cu, cc) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00650345$   
 $we (5.4c) = 0.00563796$   
 $ase ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo_1 = 340.00$   
 $ho_1 = 610.00$   
 $bi2_1 = 975400.00$   
 $ase2 = Max(ase1, ase2) = 0.14776895$   
 $bo_2 = 192.00$   
 $ho_2 = 492.00$   
 $bi2_2 = 557856.00$   
 $psh, min * F_{ywe} = Min(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.25908$

$psh, x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25223$   
 $ps1 (external) = (Ash1 * h1 / s1) / A_{sec} = 0.00261799$   
 $Ash1 = Astir_1 * ns_1 = 157.0796$   
 No stirups,  $ns_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 (internal) = (Ash2 * h2 / s2) / A_{sec} = 0.00062519$   
 $Ash2 = Astir_2 * ns_2 = 100.531$   
 No stirups,  $ns_2 = 2.00$   
 $h2 = 500.00$

$psh, y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25908$   
 $ps1 (external) = (Ash1 * h1 / s1) / A_{sec} = 0.00156298$   
 $Ash1 = Astir_1 * ns_1 = 157.0796$   
 No stirups,  $ns_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 (internal) = (Ash2 * h2 / s2) / A_{sec} = 0.00025008$   
 $Ash2 = Astir_2 * ns_2 = 100.531$   
 No stirups,  $ns_2 = 2.00$   
 $h2 = 200.00$

$A_{sec} = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fywe1 = 694.45$   
 $fywe2 = 694.45$   
 $fce = 33.00$

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

$y1 = 0.0025$   
 $sh1 = 0.008$   
 $ft1 = 833.34$   
 $fy1 = 694.45$   
 $su1 = 0.032$

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  $fs1 = (fs, jacket * A_{sl, ten, jacket} + fs, core * A_{sl, ten, core}) / A_{sl, ten} = 694.45$

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

$y2 = 0.0025$   
 $sh2 = 0.008$

$$ft2 = 833.34$$

$$fy2 = 694.45$$

$$su2 = 0.032$$

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

$$\text{with } fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45$$

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

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 833.34$$

$$fyv = 694.45$$

$$suv = 0.032$$

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

$$\text{with } fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45$$

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

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.08015524$$

$$2 = Asl,com/(b*d)*(fs2/fc) = 0.08015524$$

$$v = Asl,mid/(b*d)*(fsv/fc) = 0.04892233$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 34.07073$$

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

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

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.09611636$$

$$2 = Asl,com/(b*d)*(fs2/fc) = 0.09611636$$

$$v = Asl,mid/(b*d)*(fsv/fc) = 0.05866412$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

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

---->

$$su (4.9) = 0.13857861$$

$$Mu = MRc (4.14) = 3.0743E+008$$

$$u = su (4.1) = 0.00010406$$

-----  
Calculation of ratio lb/d

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

-----  
Calculation of Shear Strength  $Vr = \text{Min}(Vr1, Vr2) = 383231.42$   
-----

-----  
Calculation of Shear Strength at edge 1,  $Vr1 = 383231.42$

$Vr1 = Vn ((22.5.1.1), \text{ACI } 318-14)$   
-----

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

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

From Table (22.5.5.1), ACI 318-14:  $V_c = 197061.477$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot Area\_jacket + f'_{c\_core} \cdot Area\_core) / Area\_section = 33.00$ , but  $f'_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / \mu_u < 1 = 0.00$   
 $\mu_u = 8.6547052E-012$   
 $V_u = 6.9721474E-015$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$   
 $V_{s1} = 186169.943$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 0.00$  is calculated for jacket, with:  
 $d_2 = 160.00$   
 $A_v = 100530.965$   
 $f_y = 555.56$   
 $s = 300.00$   
 $V_{s2}$  is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)  
 $V_f$  ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

Calculation of Shear Strength at edge 2,  $V_{r2} = 383231.42$   
 $V_{r2} = V_n$  ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14:  $V_c = 197061.477$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot Area\_jacket + f'_{c\_core} \cdot Area\_core) / Area\_section = 33.00$ , but  $f'_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / \mu_u < 1 = 0.00$   
 $\mu_u = 1.2266780E-011$   
 $V_u = 6.9721474E-015$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$   
 $V_{s1} = 186169.943$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 0.00$  is calculated for jacket, with:  
 $d = 160.00$   
 $A_v = 100530.965$   
 $f_y = 555.56$   
 $s = 300.00$   
 $V_{s2}$  is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)  
 $V_f$  ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

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

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

At local axis: 2

Integration Section: (a)

Section Type: rcjars

#### Constant Properties

Knowledge Factor,  $\gamma = 1.00$

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

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups closed at  $135^\circ$ )

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,  $M = 1.1047E+007$

Shear Force,  $V_2 = -8.4049242E-014$

Shear Force,  $V_3 = 859.7793$

Axial Force,  $F = -4363.489$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $A_{sl} = 709.9999$

-Compression:  $A_{sc} = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

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

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

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

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension:  $A_{sl,ten,jacket} = 402.1239$

-Compression:  $A_{sl,com,jacket} = 804.2477$

-Middle:  $A_{sl,mid,jacket} = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

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

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

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

Mean Diameter of Tension Reinforcement,  $DbL = 15.00$

New component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u,R = 1.0^*$   $u = 0.01674201$

$u = \gamma + \rho = 0.01674201$

- Calculation of  $\phi_y$  -

$$\phi_y = (M_y * L_s / 3) / E_{eff} = 0.00674201 \text{ ((4.29), Biskinis Phd)}$$
$$M_y = 2.7374E+008$$
$$L_s = M/V \text{ (with } L_s > 0.1 * L \text{ and } L_s < 2 * L) = 6000.00$$
$$\text{From table 10.5, ASCE 41\_17: } E_{eff} = 0.3 * E_c * I_g = 8.1204E+013$$

Calculation of Yielding Moment  $M_y$

Calculation of  $\phi_y$  and  $M_y$  according to Annex 7 -

$$\phi_y = \text{Min}(\phi_{y\_ten}, \phi_{y\_com})$$
$$\phi_{y\_ten} = 5.4349766E-006$$
$$\text{with } f_y = 555.56$$
$$d = 627.00$$
$$\phi_y = 0.18485333$$
$$A = 0.00951372$$
$$B = 0.00406512$$
$$\text{with } p_t = 0.00283094$$
$$p_c = 0.00504809$$
$$p_v = 0.00160336$$
$$N = 4363.489$$
$$b = 400.00$$
$$\rho = 0.06858054$$
$$\phi_{y\_comp} = 1.9036374E-005$$
$$\text{with } f_c = 33.00$$
$$E_c = 26999.444$$
$$\phi_y = 0.18432314$$
$$A = 0.00944286$$
$$B = 0.0040338$$
$$\text{with } E_s = 200000.00$$

Calculation of ratio  $l_b/d$

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

- Calculation of  $\phi_p$  -

From table 10-7:  $\phi_p = 0.01$

with:

- Condition i occurred

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

shear control ratio  $V_p/V_o = 0.90705729$

- Transverse Reinforcement: C

- Stirrup Spacing  $\leq d/3$

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

$$= 6.1436951E-005$$

- Stirrup Spacing  $\leq d/2$

$d = d_{external} = 627.00$

$s = s_{external} = 150.00$

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

$V_s = 386302.632$ , already given in calculation of shear control ratio

design Shear = 859.7793

- ( $\rho - \rho'$ )/ $\rho_{bal} = -0.22420649$

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

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

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

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

From (B-1), ACI 318-11:  $\rho_{bal} = 0.01704017$

$$f_c = (f_{c\_jacket} * \text{Area}_{jacket} + f_{c\_core} * \text{Area}_{core}) / \text{section\_area} = 33.00$$

$f_y = f_{y\_jacket\_bars} = 555.56$

From 10.2.7.3, ACI 318-11:  $\phi_1 = 0.65$

$$\text{From fig R10.3.3, ACI 318-11 (Ence 454, too): } 87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + \phi_y) = 0.51922877$$

$$y = 0.0027778$$

-  $V/(bw*d*fc^{0.5}) = 0.00718664$ , NOTE: units in lb & in

$$bw = 400.00$$

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

At local axis: 2

Integration Section: (a)

### Calculation No. 3

beam B1, Floor 1

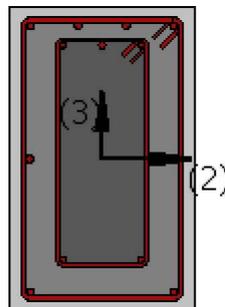
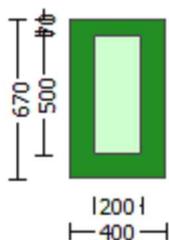
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity 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, = 1.00

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

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

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$   
Concrete Elasticity,  $E_c = 26999.444$   
Steel Elasticity,  $E_s = 200000.00$   
External Height,  $H = 670.00$   
External Width,  $W = 400.00$   
Internal Height,  $H = 500.00$   
Internal Width,  $W = 200.00$   
Cover Thickness,  $c = 25.00$   
Element Length,  $L = 3000.00$   
Primary Member  
Smooth Bars  
Ductile Steel  
With Detailing for Earthquake Resistance (including stirrups closed at  $135^\circ$ )  
Longitudinal Bars With Ends Lapped Starting at the End Sections  
Adequate Lap Length ( $l_o/l_{ou,min} = l_b/l_d \geq 1$ )  
No FRP Wrapping

-----  
Stepwise Properties  
-----

EDGE -A-  
Bending Moment,  $M_a = 1.1047E+007$   
Shear Force,  $V_a = 859.7793$   
EDGE -B-  
Bending Moment,  $M_b = 1.5895E+007$   
Shear Force,  $V_b = 18821.487$   
BOTH EDGES  
Axial Force,  $F = -4363.489$   
Longitudinal Reinforcement Area Distribution (in 2 divisions)  
-Tension:  $A_{st} = 709.9999$   
-Compression:  $A_{sc} = 1668.186$   
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $A_{st,ten} = 709.9999$   
-Compression:  $A_{sc,com} = 1266.062$   
-Middle:  $A_{sc,mid} = 402.1239$   
Mean Diameter of Tension Reinforcement,  $Db_{L,ten} = 15.00$

-----  
New component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $V_R = 1.0 \cdot V_n = 486182.768$   
 $V_n$  ((22.5.1.1), ACI 318-14) = 486182.768

-----  
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:  $V_c = 172023.503$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_c\_jacket \cdot Area\_jacket + f'_c\_core \cdot Area\_core) / Area\_section = 25.00$ , but  $f'_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / M_u < 1 = 0.04171521$   
 $M_u = 1.1047E+007$   
 $V_u = 859.7793$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 314159.265$   
 $V_{s1} = 280648.944$  is calculated for jacket, with:  
 $d = 536.00$   
 $A_v = 157079.633$   
 $f_y = 500.00$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 33510.322$  is calculated for core, with:  
 $d = 400.00$   
 $A_v = 100530.965$

$f_y = 500.00$

$s = 300.00$

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

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

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

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

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

At local axis: 3

Integration Section: (a)

## Calculation No. 4

beam B1, Floor 1

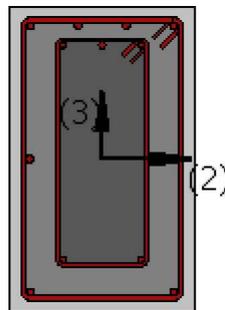
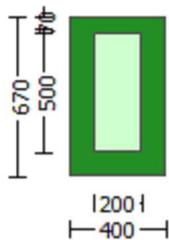
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (  $\theta$  )

Edge: Start

Local Axis: (3)



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

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,  
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

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

Existing Column

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

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.03245

Element Length,  $L = 3000.00$

Primary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

-----  
Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force,  $V_a = 9840.633$

EDGE -B-

Shear Force,  $V_b = 9840.633$

BOTH EDGES

Axial Force,  $F = -2237.255$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $A_{st} = 709.9999$

-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 ,  $V_e/V_r = 0.90705729$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 506319.489$

with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 7.4472E+008$

$M_{u1+} = 4.3734E+008$ , 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

$M_{u1-} = 7.4472E+008$ , 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

$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 7.4472E+008$

$M_{u2+} = 4.3734E+008$ , 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

$M_{u2-} = 7.4472E+008$ , is the ultimate moment strength at the edge 2 of the member in the opposite moment  
direction which is defined for the the static loading combination

and

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

with

$V_1 = 9840.633$ , is the shear force acting at edge 1 for the the static loading combination

$V_2 = 9840.633$ , is the shear force acting at edge 2 for the the static loading combination

-----  
Calculation of Mu1+  
-----

-----  
Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:

$$\mu = 5.6088283E-005$$

$$Mu = 4.3734E+008$$

-----

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear\_factor} * \text{Max}(\mu, c_o) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu = 0.00650345$$

$$\mu_e \text{ (5.4c)} = 0.00563796$$

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

$$\mu_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

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

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

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

-----

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

-----

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

-----

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

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 = 694.45

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

y2 = 0.0025

sh2 = 0.008

ft2 = 833.34

fy2 = 694.45

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 = 694.45

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

yv = 0.0025

shv = 0.008

ftv = 833.34

fyv = 694.45

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 = 694.45

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

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.05957415

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.10623177

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.03374111

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07073

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.0736092

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.13125889

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.04169017

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.09006517

Mu = MRc (4.14) = 4.3734E+008

u = su (4.1) = 5.6088283E-005

-----  
Calculation of ratio lb/d  
-----

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

Calculation of  $\mu_1$ -

Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:

$$\mu = 5.9367084E-005$$

$$\mu_u = 7.4472E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu_u: \mu_u^* = \text{shear\_factor} * \text{Max}(\mu_u, \mu_c) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu_u = 0.00650345$$

$$\mu_{ue} \text{ (5.4c)} = 0.00563796$$

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

$$a_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

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

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

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

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A.5), TBDY), TBDY: } \mu_c = 0.00232446$$

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

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

with fs1 = (fs,jacket\*Asl,ten,jacket + fs,core\*Asl,ten,core)/Asl,ten = 694.45

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

y2 = 0.0025

sh2 = 0.008

ft2 = 833.34

fy2 = 694.45

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 = 694.45

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

yv = 0.0025

shv = 0.008

ftv = 833.34

fyv = 694.45

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 = 694.45

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

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.10623177

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.05957415

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.03374111

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07073

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.13125889

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.0736092

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.04169017

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) = 0.1403202

Mu = MRc (4.15) = 7.4472E+008

$$u = s_u(4.1) = 5.9367084E-005$$

Calculation of ratio  $l_b/d$

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

Calculation of  $\mu_{2+}$

Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:

$$u = 5.6088283E-005$$

$$\mu = 4.3734E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear\_factor} * \text{Max}(\mu_c, \mu_{cc}) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu_c = 0.00650345$$

$$\mu_{cc}(5.4c) = 0.00563796$$

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

$$a_{se1} = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i2_2} = 557856.00$$

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

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

c = confinement factor = 1.03245

y1 = 0.0025

sh1 = 0.008

ft1 = 833.34

fy1 = 694.45

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

with fs1 = (fs,jacket\*Asl,ten,jacket + fs,core\*Asl,ten,core)/Asl,ten = 694.45

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

y2 = 0.0025

sh2 = 0.008

ft2 = 833.34

fy2 = 694.45

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 = 694.45

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

yv = 0.0025

shv = 0.008

ftv = 833.34

fyv = 694.45

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

with fsv = (fs,jacket\*Asl,mid,jacket + fs,mid\*Asl,mid,core)/Asl,mid = 694.45

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

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.05957415

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.10623177

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.03374111

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07073

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.0736092

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.13125889

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.04169017

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$s_u(4.9) = 0.09006517$$

$$\mu = M_{Rc}(4.14) = 4.3734E+008$$

$$u = s_u(4.1) = 5.6088283E-005$$

-----  
Calculation of ratio  $l_b/l_d$

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

-----  
Calculation of  $\mu_2$ -

-----  
Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:

$$u = 5.9367084E-005$$

$$\mu = 7.4472E+008$$

-----  
with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear\_factor} * \text{Max}(c_u, c_c) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00650345$$

$$w_e(5.4c) = 0.00563796$$

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

$$a_{se1} = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i21} = 975400.00$$

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

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i22} = 557856.00$$

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

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

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

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

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

-----  
$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$fy_{we2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

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.

$$\text{with } fs_1 = (fs_{\text{jacket}} * Asl, \text{ten, jacket} + fs_{\text{core}} * Asl, \text{ten, core}) / Asl, \text{ten} = 694.45$$

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

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 833.34$$

$$fy_2 = 694.45$$

$$su_2 = 0.032$$

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.

$$\text{with } fs_2 = (fs_{\text{jacket}} * Asl, \text{com, jacket} + fs_{\text{core}} * Asl, \text{com, core}) / Asl, \text{com} = 694.45$$

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

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 833.34$$

$$fy_v = 694.45$$

$$suv = 0.032$$

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.

$$\text{with } fsv = (fs_{\text{jacket}} * Asl, \text{mid, jacket} + fs_{\text{mid}} * Asl, \text{mid, core}) / Asl, \text{mid} = 694.45$$

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

$$1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.10623177$$

$$2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.059574115$$

$$v = Asl, \text{mid} / (b * d) * (fsv / f_c) = 0.03374111$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, \text{TBDY}) = 34.07073$$

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

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

$$1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.13125889$$

$$2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.0736092$$

$$v = Asl, \text{mid} / (b * d) * (fsv / f_c) = 0.04169017$$

Case/Assumption: Unconfinedsd 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

---->

$\mu_u$  (4.8) = 0.1403202

$\mu_u = M/R_c$  (4.15) = 7.4472E+008

$u = \mu_u$  (4.1) = 5.9367084E-005

-----  
Calculation of ratio  $l_b/d$

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

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

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

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

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

-----  
From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
= 1 (normal-weight concrete)

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

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

$A_s$  (tension reinf.) = 709.9999

$b_w = 400.00$

$d = 536.00$

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

$\mu_u = 1.0197E+006$

$V_u = 9840.633$

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

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

$d = 536.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 150.00$

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

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

$d_2 = 400.00$

$A_v = 100530.965$

$f_y = 555.56$

$s = 300.00$

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

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

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

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

-----  
Calculation of Shear Strength at edge 2,  $V_{r2} = 558200.119$

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

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

-----  
From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
= 1 (normal-weight concrete)

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

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

$A_s$  (tension reinf.) = 709.9999

$b_w = 400.00$

d = 536.00  
Vu\*d/Mu < 1 = 1.00  
Mu = 1.0197E+006  
Vu = 9840.633

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

Vs1 = 311834.654 is calculated for jacket, with:

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

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

Vs2 = 37233.989 is calculated for jacket, with:

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

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

2(1-s/d) = 0.50

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

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

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

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

Constant Properties

-----  
Knowledge Factor, = 1.00  
Mean strength values are used for both shear and moment calculations.  
Consequently:

Jacket

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

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

Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00

Existing Column

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

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

Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00

#####

Note: Especially for the calculation of moment strengths,  
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, fs = 1.25\*fsm = 694.45

Existing Column

New material: Steel Strength, fs = 1.25\*fsm = 694.45

#####

External Height, H = 670.00

External Width, W = 400.00

Internal Height, H = 500.00

Internal Width, W = 200.00

Cover Thickness, c = 25.00

Mean Confinement Factor overall section = 1.03245

Element Length, L = 3000.00

Primary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ( $l_o/l_{ou}, \min \geq 1$ )  
No FRP Wrapping

-----  
Stepwise Properties  
-----

At local axis: 2  
EDGE -A-  
Shear Force,  $V_a = -6.9721474E-015$   
EDGE -B-  
Shear Force,  $V_b = 6.9721474E-015$   
BOTH EDGES  
Axial Force,  $F = -2237.255$   
Longitudinal Reinforcement Area Distribution (in 2 divisions)  
-Tension:  $As_t = 709.9999$   
-Compression:  $As_c = 1668.186$   
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $As_{t,ten} = 911.0619$   
-Compression:  $As_{c,com} = 911.0619$   
-Middle:  $As_{c,mid} = 556.0619$   
-----  
-----

Calculation of Shear Capacity ratio,  $V_e/V_r = 0.53480887$   
Member Controlled by Flexure ( $V_e/V_r < 1$ )  
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n / 2 = 204955.561$   
with  
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 3.0743E+008$   
 $Mu_{1+} = 3.0743E+008$ , 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  
 $Mu_{1-} = 3.0743E+008$ , 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  
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 3.0743E+008$   
 $Mu_{2+} = 3.0743E+008$ , 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  
 $Mu_{2-} = 3.0743E+008$ , 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  
 $V_1 = -6.9721474E-015$ , is the shear force acting at edge 1 for the the static loading combination  
 $V_2 = 6.9721474E-015$ , is the shear force acting at edge 2 for the the static loading combination

-----  
Calculation of  $Mu_{1+}$   
-----

-----  
Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:  
 $\phi_u = 0.00010406$   
 $M_u = 3.0743E+008$   
-----

with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $\phi_c \text{ (5A.5, TBDY)} = 0.002$   
Final value of  $\phi_{cu}$ :  $\phi_{cu}^* = \text{shear\_factor} * \text{Max}(\phi_{cu}, \phi_c) = 0.00650345$   
The Shear\_factor is considered equal to 1 (pure moment strength)  
From (5.4b), TBDY:  $\phi_{cu} = 0.00650345$   
 $\phi_{we} \text{ (5.4c)} = 0.00563796$   
 $\phi_{ase} \text{ ((5.4d), TBDY)} = (ase_1 * A_{ext} + ase_2 * A_{int}) / A_{sec} = 0.14776895$   
 $ase_1 = 0.14776895$

bo\_1 = 340.00  
ho\_1 = 610.00  
bi2\_1 = 975400.00  
ase2 = Max(ase1,ase2) = 0.14776895  
bo\_2 = 192.00  
ho\_2 = 492.00  
bi2\_2 = 557856.00  
psh,min\*Fywe = Min(psh,x\*Fywe , psh,y\*Fywe) = 1.25908

psh\_x\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 2.25223  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00261799  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 670.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00062519  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00156298  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 400.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00025008  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 200.00

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

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

y1 = 0.0025  
sh1 = 0.008  
ft1 = 833.34  
fy1 = 694.45  
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 = 694.45

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

y2 = 0.0025  
sh2 = 0.008  
ft2 = 833.34  
fy2 = 694.45  
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  $f_{s2} = (f_{s,jacket} \cdot A_{s,com,jacket} + f_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 694.45$   
 with  $E_{s2} = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 200000.00$   
 $y_v = 0.0025$   
 $sh_v = 0.008$   
 $ft_v = 833.34$   
 $fy_v = 694.45$   
 $suv = 0.032$   
 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  $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 694.45$   
 with  $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.08015524$   
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.08015524$   
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.04892233$   
 and confined core properties:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.09611636$   
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.09611636$   
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.05866412$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' does not satisfy Eq. (4.3)  
 --->  
 $v < v_{s,c}$  - RHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.13857861$   
 $Mu = MRc (4.14) = 3.0743E+008$   
 $u = su (4.1) = 0.00010406$

-----  
 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:

$u = 0.00010406$   
 $Mu = 3.0743E+008$

-----  
 with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $co (5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = \text{shear\_factor} \cdot \text{Max}(cu, cc) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00650345$

we (5.4c) = 0.00563796  
ase ((5.4d), TBDY) = (ase1\*Aext+ase2\*Aint)/Asec = 0.14776895  
ase1 = 0.14776895  
bo\_1 = 340.00  
ho\_1 = 610.00  
bi2\_1 = 975400.00  
ase2 = Max(ase1,ase2) = 0.14776895  
bo\_2 = 192.00  
ho\_2 = 492.00  
bi2\_2 = 557856.00  
psh,min\*Fywe = Min(psh,x\*Fywe , psh,y\*Fywe) = 1.25908

psh\_x\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 2.25223  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00261799  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 670.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00062519  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00156298  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 400.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00025008  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

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

c = confinement factor = 1.03245

y1 = 0.0025

sh1 = 0.008

ft1 = 833.34

fy1 = 694.45

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 = (fsjacket\*Asl,ten,jacket + fs,core\*Asl,ten,core)/Asl,ten = 694.45

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

y2 = 0.0025

sh2 = 0.008

ft2 = 833.34

fy2 = 694.45

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

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

with  $fs_2 = (fs_{jacket} \cdot Asl_{,com,jacket} + fs_{core} \cdot Asl_{,com,core}) / Asl_{,com} = 694.45$

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

$y_v = 0.0025$

$sh_v = 0.008$

$ft_v = 833.34$

$fy_v = 694.45$

$suv = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor and also multiplied by the shear\_factor according to 15.7.1.4, with Shear\_factor = 1.00

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

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

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

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

For calculation of  $es_{uv,nominal}$  and  $y_v$ ,  $sh_v, ft_v, fy_v$ , it is considered characteristic value  $fs_v = fs_v/1.2$ , from table 5.1, TBDY.

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

with  $fs_v = (fs_{jacket} \cdot Asl_{,mid,jacket} + fs_{mid} \cdot Asl_{,mid,core}) / Asl_{,mid} = 694.45$

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

$1 = Asl_{,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.08015524$

$2 = Asl_{,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.08015524$

$v = Asl_{,mid} / (b \cdot d) \cdot (fs_v / fc) = 0.04892233$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

$fcc$  (5A.2, TBDY) = 34.07073

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

$c$  = confinement factor = 1.03245

$1 = Asl_{,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.09611636$

$2 = Asl_{,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.09611636$

$v = Asl_{,mid} / (b \cdot d) \cdot (fs_v / fc) = 0.05866412$

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) = 0.13857861

$Mu = MRc$  (4.14) = 3.0743E+008

$u = su$  (4.1) = 0.00010406

-----  
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:

$u = 0.00010406$

$Mu = 3.0743E+008$

-----  
with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$fc = 33.00$

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

Final value of  $cu$ :  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00650345$   
 $w_e$  (5.4c) = 0.00563796  
 $ase$  ((5.4d), TBDY) =  $(ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo\_1 = 340.00$   
 $ho\_1 = 610.00$   
 $bi2\_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$   
 $psh_{min} * Fy_{we} = \text{Min}(psh_x * Fy_{we}, psh_y * Fy_{we}) = 1.25908$

-----  
 $psh_x * Fy_{we} = psh1 * Fy_{we1} + ps2 * Fy_{we2} = 2.25223$   
 $ps1$  (external) =  $(Ash1 * h1 / s1) / A_{sec} = 0.00261799$   
 $Ash1 = Astir\_1 * ns\_1 = 157.0796$   
 No stirups,  $ns\_1 = 2.00$   
 $h1 = 670.00$   
 $ps2$  (internal) =  $(Ash2 * h2 / s2) / A_{sec} = 0.00062519$   
 $Ash2 = Astir\_2 * ns\_2 = 100.531$   
 No stirups,  $ns\_2 = 2.00$   
 $h2 = 500.00$

-----  
 $psh_y * Fy_{we} = psh1 * Fy_{we1} + ps2 * Fy_{we2} = 1.25908$   
 $ps1$  (external) =  $(Ash1 * h1 / s1) / A_{sec} = 0.00156298$   
 $Ash1 = Astir\_1 * ns\_1 = 157.0796$   
 No stirups,  $ns\_1 = 2.00$   
 $h1 = 400.00$   
 $ps2$  (internal) =  $(Ash2 * h2 / s2) / A_{sec} = 0.00025008$   
 $Ash2 = Astir\_2 * ns\_2 = 100.531$   
 No stirups,  $ns\_2 = 2.00$   
 $h2 = 200.00$

-----  
 $A_{sec} = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fy_{we1} = 694.45$   
 $fy_{we2} = 694.45$   
 $f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY:  $cc = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$

$y1 = 0.0025$   
 $sh1 = 0.008$   
 $ft1 = 833.34$   
 $fy1 = 694.45$   
 $su1 = 0.032$

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.

with  $fs1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 694.45$

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

$y2 = 0.0025$   
 $sh2 = 0.008$   
 $ft2 = 833.34$   
 $fy2 = 694.45$   
 $su2 = 0.032$

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

$$l_0/l_{0u,min} = l_b/l_{b,min} = 1.00$$

$$s_u2 = 0.4 * e_{su2,nominal} ((5.5), TBDY) = 0.032$$

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.

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

$$\text{with } f_{s2} = (f_{s,jacket} * A_{s1,com,jacket} + f_{s,core} * A_{s1,com,core}) / A_{s1,com} = 694.45$$

$$\text{with } E_{s2} = (E_{s,jacket} * A_{s1,com,jacket} + E_{s,core} * A_{s1,com,core}) / A_{s1,com} = 200000.00$$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 833.34$$

$$fy_v = 694.45$$

$$s_{uv} = 0.032$$

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

$$l_0/l_{0u,min} = l_b/l_d = 1.00$$

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

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

$$\text{with } f_{sv} = (f_{s,jacket} * A_{s1,mid,jacket} + f_{s,mid} * A_{s1,mid,core}) / A_{s1,mid} = 694.45$$

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

$$1 = A_{s1,ten} / (b * d) * (f_{s1} / f_c) = 0.08015524$$

$$2 = A_{s1,com} / (b * d) * (f_{s2} / f_c) = 0.08015524$$

$$v = A_{s1,mid} / (b * d) * (f_{sv} / f_c) = 0.04892233$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 34.07073$$

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

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

$$1 = A_{s1,ten} / (b * d) * (f_{s1} / f_c) = 0.09611636$$

$$2 = A_{s1,com} / (b * d) * (f_{s2} / f_c) = 0.09611636$$

$$v = A_{s1,mid} / (b * d) * (f_{sv} / f_c) = 0.05866412$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

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

---->

$$s_u (4.9) = 0.13857861$$

$$\mu_u = M_{Rc} (4.14) = 3.0743E+008$$

$$u = s_u (4.1) = 0.00010406$$

-----  
Calculation of ratio  $l_b/l_d$

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

-----  
Calculation of  $\mu_u$ -

-----  
Calculation of ultimate curvature  $\mu_u$  according to 4.1, Biskinis/Fardis 2013:

$$u = 0.00010406$$

$$\mu_u = 3.0743E+008$$

-----  
with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$fc = 33.00$$

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

$$\text{Final value of } cu: cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } cu = 0.00650345$$

$$we (5.4c) = 0.00563796$$

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

$$ase1 = 0.14776895$$

$$bo\_1 = 340.00$$

$$ho\_1 = 610.00$$

$$bi2\_1 = 975400.00$$

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

$$bo\_2 = 192.00$$

$$ho\_2 = 492.00$$

$$bi2\_2 = 557856.00$$

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

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

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

$$Ash1 = Astir\_1 * ns\_1 = 157.0796$$

$$\text{No stirups, } ns\_1 = 2.00$$

$$h1 = 670.00$$

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

$$Ash2 = Astir\_2 * ns\_2 = 100.531$$

$$\text{No stirups, } ns\_2 = 2.00$$

$$h2 = 500.00$$

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

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

$$Ash1 = Astir\_1 * ns\_1 = 157.0796$$

$$\text{No stirups, } ns\_1 = 2.00$$

$$h1 = 400.00$$

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

$$Ash2 = Astir\_2 * ns\_2 = 100.531$$

$$\text{No stirups, } ns\_2 = 2.00$$

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 694.45$$

$$fce = 33.00$$

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

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

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 833.34$$

$$fy1 = 694.45$$

$$su1 = 0.032$$

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

$$lo/lou_{min} = lb/ld = 1.00$$

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

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

For calculation of esu1\_nominal and y1, sh1, ft1, fy1, it is considered characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

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

$$\text{with } fs1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 694.45$$

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

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 833.34$$

$$fy2 = 694.45$$

$$su2 = 0.032$$

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

$$l_0/l_{0u,min} = l_b/l_{b,min} = 1.00$$

$$s_u2 = 0.4 \cdot e_{su2,nominal} ((5.5), TBDY) = 0.032$$

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.

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

$$\text{with } f_{s2} = (f_{s,jacket} \cdot A_{sl,com,jacket} + f_{s,core} \cdot A_{sl,com,core}) / A_{sl,com} = 694.45$$

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

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 833.34$$

$$fy_v = 694.45$$

$$s_{uv} = 0.032$$

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  $f_{sv} = f_{sv}/1.2$ , 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.

$$\text{with } f_{sv} = (f_{s,jacket} \cdot A_{sl,mid,jacket} + f_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 694.45$$

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

$$1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.08015524$$

$$2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.08015524$$

$$v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.04892233$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 34.07073$$

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

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

$$1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.09611636$$

$$2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.09611636$$

$$v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.05866412$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

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

--->

$$s_u (4.9) = 0.13857861$$

$$\mu = MR_c (4.14) = 3.0743E+008$$

$$u = s_u (4.1) = 0.00010406$$

Calculation of ratio  $l_b/l_d$

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

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

Calculation of Shear Strength at edge 1,  $V_{r1} = 383231.42$

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

NOTE: In expression (22.5.1.1) 'V<sub>w</sub>' is replaced by 'V<sub>w</sub> + f<sub>v</sub>V<sub>f</sub>'  
where V<sub>f</sub> is the contribution of FRPs (11.3), ACI 440).

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

= 1 (normal-weight concrete)  
Mean concrete strength:  $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 33.00$ , but  $f_c'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $p_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / \mu_u < 1 = 0.00$   
 $\mu_u = 8.6547052E-012$   
 $V_u = 6.9721474E-015$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$   
 $V_{s1} = 186169.943$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 0.00$  is calculated for jacket, with:  
 $d_2 = 160.00$   
 $A_v = 100530.965$   
 $f_y = 555.56$   
 $s = 300.00$   
 $V_{s2}$  is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)  
 $V_f$  ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

-----  
Calculation of Shear Strength at edge 2,  $V_{r2} = 383231.42$   
 $V_{r2} = V_n$  (22.5.1.1), ACI 318-14)

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

-----  
From Table (22.5.5.1), ACI 318-14:  $V_c = 197061.477$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 33.00$ , but  $f_c'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $p_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / \mu_u < 1 = 0.00$   
 $\mu_u = 1.2266780E-011$   
 $V_u = 6.9721474E-015$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$   
 $V_{s1} = 186169.943$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 0.00$  is calculated for jacket, with:  
 $d = 160.00$   
 $A_v = 100530.965$   
 $f_y = 555.56$   
 $s = 300.00$   
 $V_{s2}$  is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)  
 $V_f$  ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

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

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

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

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

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups 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,  $M = -1.5808831E-010$

Shear Force,  $V_2 = -8.4049242E-014$

Shear Force,  $V_3 = 859.7793$

Axial Force,  $F = -4363.489$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $A_{sl} = 709.9999$

-Compression:  $A_{sc} = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $A_{sl,ten} = 911.0619$

-Compression:  $A_{sl,com} = 911.0619$

-Middle:  $A_{sl,mid} = 556.0619$

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension:  $A_{sl,ten,jacket} = 603.1858$

-Compression:  $A_{sl,com,jacket} = 603.1858$

-Middle:  $A_{sl,mid,jacket} = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

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

-Compression:  $A_{sl,com,core} = 307.8761$

-Middle:  $A_{sl,mid,core} = 153.938$

Mean Diameter of Tension Reinforcement,  $DbL = 15.20$

New component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u_{,R} = 1.0^*$   $u = 0.0084424$

$u = \gamma + \rho = 0.0084424$

- Calculation of  $\gamma$  -

$\gamma = (M_y * L_s / 3) / E_{eff} = 0.0034424 ((4.29), Biskinis Phd)$

$M_y = 1.9927E+008$   
 $L_s = M/V$  (with  $L_s > 0.1*L$  and  $L_s < 2*L$ ) = 1500.00  
From table 10.5, ASCE 41\_17:  $E_{eff} = 0.3*E_c*I_g = 2.8943E+013$

Calculation of Yielding Moment  $M_y$

Calculation of  $\phi_y$  and  $M_y$  according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$   
 $y_{ten} = 1.0021098E-005$   
with  $f_y = 555.56$   
 $d = 357.00$   
 $y = 0.22354295$   
 $A = 0.0099755$   
 $B = 0.00560296$   
with  $pt = 0.00380895$   
 $pc = 0.00380895$   
 $pv = 0.00232477$   
 $N = 4363.489$   
 $b = 670.00$   
 $\rho = 0.12044818$   
 $y_{comp} = 2.7617879E-005$   
with  $f_c = 33.00$   
 $E_c = 26999.444$   
 $y = 0.22313777$   
 $A = 0.0099012$   
 $B = 0.00557012$   
with  $E_s = 200000.00$

Calculation of ratio  $l_b/d$

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

- Calculation of  $\rho$  -

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

with:

- Condition i occurred

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

shear control ratio  $V_p/V_o = 0.53480887$

- Transverse Reinforcement: NC

- Stirrup Spacing  $> d/3$

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

$\rho = 1.5731932E-022$

- Stirrup Spacing  $\leq d/2$

$d = d_{external} = 357.00$

$s = s_{external} = 150.00$

- Strength provided by hoops  $V_s < 3/4*$ design Shear

$V_s = 215957.134$ , already given in calculation of shear control ratio

design Shear =  $8.4049242E-014$

- ( $\rho - \rho'_{bal}$ )/  $\rho_{bal} = -0.23508921$

$\rho = A_{st}/(b_w*d) = 0.00296835$

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

$\rho' = A_{sc}/(b_w*d) = 0.00697431$

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

From (B-1), ACI 318-11:  $\rho_{bal} = 0.01704017$

$f_c = (f_{c,jacket}*Area_{jacket} + f_{c,core}*Area_{core})/section\_area = 33.00$

$f_y = f_{y,jacket\_bars} = 555.56$

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

From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + \phi) = 0.51922877$

$\phi = 0.0027778$

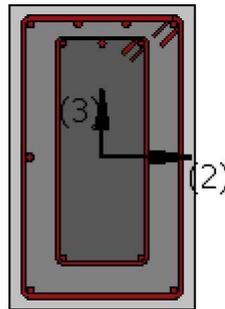
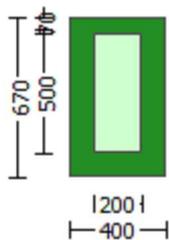
-  $V/(b_w*d*f_c^{0.5}) = 7.3664296E-019$ , NOTE: units in lb & in

$b_w = 670.00$

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1  
At local axis: 3  
Integration Section: (a)

## Calculation No. 5

beam B1, Floor 1  
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)  
Analysis: Uniform +X  
Check: Shear capacity VRd  
Edge: End  
Local Axis: (2)



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

Constant Properties

Knowledge Factor,  $\gamma = 1.00$   
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.  
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17  
Consequently:  
Jacket  
New material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$   
New material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$   
Concrete Elasticity,  $E_c = 26999.444$   
Steel Elasticity,  $E_s = 200000.00$   
Existing Column  
New material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$   
New material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$   
Concrete Elasticity,  $E_c = 26999.444$   
Steel Elasticity,  $E_s = 200000.00$

External Height, H = 670.00  
External Width, W = 400.00  
Internal Height, H = 500.00  
Internal Width, W = 200.00  
Cover Thickness, c = 25.00  
Element Length, L = 3000.00  
Primary Member  
Smooth Bars  
Ductile Steel  
With Detailing for Earthquake Resistance (including stirrups closed at 135°)  
Longitudinal Bars With Ends Lapped Starting at the End Sections  
Adequate Lap Length ( $l_o/l_{ou,min} = l_b/l_d \geq 1$ )  
No FRP Wrapping

-----  
Stepwise Properties  
-----

EDGE -A-  
Bending Moment,  $M_a = -1.5808831E-010$   
Shear Force,  $V_a = -8.4049242E-014$   
EDGE -B-  
Bending Moment,  $M_b = -9.4153455E-011$   
Shear Force,  $V_b = 8.4049242E-014$   
BOTH EDGES  
Axial Force,  $F = -4363.489$   
Longitudinal Reinforcement Area Distribution (in 2 divisions)  
-Tension:  $A_{st} = 709.9999$   
-Compression:  $A_{sc} = 1668.186$   
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $A_{st,ten} = 911.0619$   
-Compression:  $A_{sc,com} = 911.0619$   
-Middle:  $A_{st,mid} = 556.0619$   
Mean Diameter of Tension Reinforcement,  $Db_{L,ten} = 15.20$

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

-----  
NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw + f<sub>v</sub>V<sub>f</sub>'  
where V<sub>f</sub> is the contribution of FRPs (11.3), ACI 440).

-----  
From Table (22.5.5.1), ACI 318-14:  $V_c = 171520.00$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c,jacket} \cdot Area_{jacket} + f'_{c,core} \cdot Area_{core}) / Area_{section} = 25.00$ , but  $f_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 9.4153455E-011$   
 $V_u = 8.4049242E-014$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 167551.608$   
 $V_{s1} = 167551.608$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 500.00$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 0.00$  is calculated for core, with:  
 $d = 160.00$   
 $A_v = 100530.965$   
 $f_y = 500.00$   
 $s = 300.00$   
 $V_{s2}$  is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

Vf ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440: Vs + Vf <= 712133.705

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

## Calculation No. 6

beam B1, Floor 1

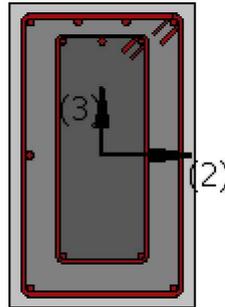
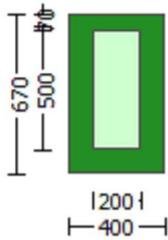
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity ( 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, = 1.00

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,  
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

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

Existing Column

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

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.03245

Element Length,  $L = 3000.00$

Primary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

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Stepwise Properties

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At local axis: 3

EDGE -A-

Shear Force,  $V_a = 9840.633$

EDGE -B-

Shear Force,  $V_b = 9840.633$

BOTH EDGES

Axial Force,  $F = -2237.255$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $As_t = 709.9999$

-Compression:  $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

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

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

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

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-----  
Calculation of Shear Capacity ratio ,  $V_e/V_r = 0.90705729$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n / 2 = 506319.489$   
with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 7.4472E+008$

$M_{u1+} = 4.3734E+008$ , 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

$M_{u1-} = 7.4472E+008$ , 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

$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 7.4472E+008$

$M_{u2+} = 4.3734E+008$ , 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

$M_{u2-} = 7.4472E+008$ , is the ultimate moment strength at the edge 2 of the member in the opposite moment  
direction which is defined for the the static loading combination

and

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

with

$V_1 = 9840.633$ , is the shear force acting at edge 1 for the the static loading combination

$V_2 = 9840.633$ , is the shear force acting at edge 2 for the the static loading combination

-----  
Calculation of  $M_{u1+}$

Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

$$u = 5.6088283E-005$$

$$Mu = 4.3734E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.00650345$$

$$w_e(5.4c) = 0.00563796$$

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

$$a_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

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

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

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

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

No stirups,  $n_{s\_1} = 2.00$

$$h_1 = 670.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

No stirups,  $n_{s\_2} = 2.00$

$$h_2 = 500.00$$

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

No stirups,  $n_{s\_1} = 2.00$

$$h_1 = 400.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

No stirups,  $n_{s\_2} = 2.00$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

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

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

$$su_1 = 0.4 * e_{su1\_nominal}((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY:  $e_{su1\_nominal} = 0.08$ ,

For calculation of  $es_{u1\_nominal}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered characteristic value  $fs_{y1} = fs_1/1.2$ , 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  $fs_1 = (fs_{jacket} \cdot A_{sl,ten,jacket} + fs_{core} \cdot A_{sl,ten,core}) / A_{sl,ten} = 694.45$

with  $Es_1 = (Es_{jacket} \cdot A_{sl,ten,jacket} + Es_{core} \cdot A_{sl,ten,core}) / A_{sl,ten} = 200000.00$

$y_2 = 0.0025$

$sh_2 = 0.008$

$ft_2 = 833.34$

$fy_2 = 694.45$

$su_2 = 0.032$

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

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

$su_2 = 0.4 \cdot es_{u2\_nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY:  $es_{u2\_nominal} = 0.08$ ,

For calculation of  $es_{u2\_nominal}$  and  $y_2, sh_2, ft_2, fy_2$ , it is considered characteristic value  $fs_{y2} = fs_2/1.2$ , from table 5.1, TBDY.

$y_2, sh_2, ft_2, fy_2$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs_2 = (fs_{jacket} \cdot A_{sl,com,jacket} + fs_{core} \cdot A_{sl,com,core}) / A_{sl,com} = 694.45$

with  $Es_2 = (Es_{jacket} \cdot A_{sl,com,jacket} + Es_{core} \cdot A_{sl,com,core}) / A_{sl,com} = 200000.00$

$y_v = 0.0025$

$sh_v = 0.008$

$ft_v = 833.34$

$fy_v = 694.45$

$su_v = 0.032$

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

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

$su_v = 0.4 \cdot es_{uv\_nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY:  $es_{uv\_nominal} = 0.08$ ,

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

For calculation of  $es_{uv\_nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered characteristic value  $fs_{yv} = f_{sv}/1.2$ , from table 5.1, TBDY.

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

with  $f_{sv} = (f_{s,jacket} \cdot A_{sl,mid,jacket} + f_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 694.45$

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

$1 = A_{sl,ten} / (b \cdot d) \cdot (fs_1 / f_c) = 0.05957415$

$2 = A_{sl,com} / (b \cdot d) \cdot (fs_2 / f_c) = 0.10623177$

$v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.03374111$

and confined core properties:

$b = 340.00$

$d = 597.00$

$d' = 13.00$

$f_{cc} (5A.2, TBDY) = 34.07073$

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

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

$1 = A_{sl,ten} / (b \cdot d) \cdot (fs_1 / f_c) = 0.0736092$

$2 = A_{sl,com} / (b \cdot d) \cdot (fs_2 / f_c) = 0.13125889$

$v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.04169017$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su (4.9) = 0.09006517$

$Mu = MRc (4.14) = 4.3734E+008$

$u = su (4.1) = 5.6088283E-005$

Calculation of ratio  $lb/ld$

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

Calculation of Mu1-

Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:

$$u = 5.9367084E-005$$

$$\mu = 7.4472E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear\_factor} * \text{Max}(c_u, c_c) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00650345$$

$$w_e (5.4c) = 0.00563796$$

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

$$a_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

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

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

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

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

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

$$l_0/l_{0u,min} = l_b/l_d = 1.00$$

$$s_u1 = 0.4 * e_{s1\_nominal} ((5.5), TBDY) = 0.032$$

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.

$$\text{with } f_{s1} = (f_{s,jacket} * A_{s,ten,jacket} + f_{s,core} * A_{s,ten,core}) / A_{s,ten} = 694.45$$

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

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 833.34$$

$$fy_2 = 694.45$$

$$s_u2 = 0.032$$

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

$$l_0/l_{0u,min} = l_b/l_{b,min} = 1.00$$

$$s_u2 = 0.4 * e_{s2\_nominal} ((5.5), TBDY) = 0.032$$

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.

$$\text{with } f_{s2} = (f_{s,jacket} * A_{s,com,jacket} + f_{s,core} * A_{s,com,core}) / A_{s,com} = 694.45$$

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

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 833.34$$

$$fy_v = 694.45$$

$$s_{uv} = 0.032$$

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

$$l_0/l_{0u,min} = l_b/l_d = 1.00$$

$$s_{uv} = 0.4 * e_{suv\_nominal} ((5.5), TBDY) = 0.032$$

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.

$$\text{with } f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 694.45$$

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

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.10623177$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.05957415$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.03374111$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 34.07073$$

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

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

$$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.13125889$$

$$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.0736092$$

$$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.04169017$$

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

--->

$$s_u (4.8) = 0.1403202$$

$$\mu_u = M R_c (4.15) = 7.4472E+008$$

$$u = s_u (4.1) = 5.9367084E-005$$

-----  
Calculation of ratio  $l_b/l_d$

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

Calculation of  $\mu_{2+}$

Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:

$$\mu = 5.6088283E-005$$

$$\mu_{2+} = 4.3734E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu_{cu}: \mu_{cu}^* = \text{shear\_factor} * \text{Max}(\mu_{cu}, \mu_{cc}) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu_{cu} = 0.00650345$$

$$\mu_{we} \text{ (5.4c)} = 0.00563796$$

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

$$\mu_{ase1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

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

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

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

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$f_{y1} = 694.45$   
 $s_{u1} = 0.032$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $s_{u1} = 0.4 * e_{s1\_nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $e_{s1\_nominal} = 0.08$ ,  
 For calculation of  $e_{s1\_nominal}$  and  $y_1, sh_1, ft_1, f_{y1}$ , it is considered  
 characteristic value  $f_{s1} = f_{s1}/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, f_{y1}$ , are also multiplied by  $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $f_{s1} = (f_{s,jacket} * A_{s1,ten,jacket} + f_{s,core} * A_{s1,ten,core}) / A_{s1,ten} = 694.45$   
 with  $E_{s1} = (E_{s,jacket} * A_{s1,ten,jacket} + E_{s,core} * A_{s1,ten,core}) / A_{s1,ten} = 200000.00$   
 $y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$   
 $f_{y2} = 694.45$   
 $s_{u2} = 0.032$   
 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  
 $l_o/l_{ou,min} = l_b/l_{b,min} = 1.00$   
 $s_{u2} = 0.4 * e_{s2\_nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $e_{s2\_nominal} = 0.08$ ,  
 For calculation of  $e_{s2\_nominal}$  and  $y_2, sh_2, ft_2, f_{y2}$ , it is considered  
 characteristic value  $f_{s2} = f_{s2}/1.2$ , from table 5.1, TBDY.  
 $y_2, sh_2, ft_2, f_{y2}$ , are also multiplied by  $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $f_{s2} = (f_{s,jacket} * A_{s2,com,jacket} + f_{s,core} * A_{s2,com,core}) / A_{s2,com} = 694.45$   
 with  $E_{s2} = (E_{s,jacket} * A_{s2,com,jacket} + E_{s,core} * A_{s2,com,core}) / A_{s2,com} = 200000.00$   
 $y_v = 0.0025$   
 $sh_v = 0.008$   
 $ft_v = 833.34$   
 $f_{y_v} = 694.45$   
 $s_{u_v} = 0.032$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $s_{u_v} = 0.4 * e_{s_{u_v}}\_nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $e_{s_{u_v}}\_nominal = 0.08$ ,  
 considering characteristic value  $f_{s_{u_v}} = f_{s_{u_v}}/1.2$ , from table 5.1, TBDY  
 For calculation of  $e_{s_{u_v}}\_nominal$  and  $y_v, sh_v, ft_v, f_{y_v}$ , it is considered  
 characteristic value  $f_{s_{u_v}} = f_{s_{u_v}}/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, f_{y1}$ , are also multiplied by  $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $f_{s_{u_v}} = (f_{s,jacket} * A_{s_{u_v},mid,jacket} + f_{s,mid} * A_{s_{u_v},mid,core}) / A_{s_{u_v},mid} = 694.45$   
 with  $E_{s_{u_v}} = (E_{s,jacket} * A_{s_{u_v},mid,jacket} + E_{s,mid} * A_{s_{u_v},mid,core}) / A_{s_{u_v},mid} = 200000.00$   
 $1 = A_{s1,ten} / (b * d) * (f_{s1} / f_c) = 0.05957415$   
 $2 = A_{s2,com} / (b * d) * (f_{s2} / f_c) = 0.10623177$   
 $v = A_{s_{u_v},mid} / (b * d) * (f_{s_{u_v}} / f_c) = 0.03374111$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = A_{s1,ten} / (b * d) * (f_{s1} / f_c) = 0.0736092$   
 $2 = A_{s2,com} / (b * d) * (f_{s2} / f_c) = 0.13125889$   
 $v = A_{s_{u_v},mid} / (b * d) * (f_{s_{u_v}} / f_c) = 0.04169017$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is satisfied  
 --->  
 $s_u (4.9) = 0.09006517$   
 $M_u = M_{Rc} (4.14) = 4.3734E+008$   
 $u = s_u (4.1) = 5.6088283E-005$

Calculation of ratio  $l_b/d$

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

Calculation of  $\mu_2$

Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:

$$\mu = 5.9367084E-005$$

$$\mu = 7.4472E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear\_factor} * \text{Max}(\mu_c, \mu_{cc}) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu_c = 0.00650345$$

$$\mu_{cc} \text{ (5.4c)} = 0.00563796$$

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

$$\mu_{ase1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

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

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

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

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

y1 = 0.0025  
sh1 = 0.008  
ft1 = 833.34  
fy1 = 694.45  
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 = 694.45

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

y2 = 0.0025  
sh2 = 0.008  
ft2 = 833.34  
fy2 = 694.45  
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 = 694.45

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

yv = 0.0025  
shv = 0.008  
ftv = 833.34  
fyv = 694.45  
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 = 694.45

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

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.10623177

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.05957415

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.03374111

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07073

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.13125889

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.0736092

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.04169017

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

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

--->

$$s_u(4.8) = 0.1403202$$

$$\mu_u = M_{Rc}(4.15) = 7.4472E+008$$

$$u = s_u(4.1) = 5.9367084E-005$$

-----  
Calculation of ratio  $l_b/d$

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

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

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

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

-----  
NOTE: In expression (22.5.1.1) 'V<sub>w</sub>' is replaced by 'V<sub>w</sub> + f\*V<sub>f</sub>'  
where V<sub>f</sub> is the contribution of FRPs (11.3), ACI 440).

$$\text{From Table (22.5.5.1), ACI 318-14: } V_c = 209131.476$$

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

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

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

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

$$b_w = 400.00$$

$$d = 536.00$$

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

$$\mu_u = 1.0197E+006$$

$$V_u = 9840.633$$

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

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

$$d = 536.00$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

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

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

$$d_2 = 400.00$$

$$A_v = 100530.965$$

$$f_y = 555.56$$

$$s = 300.00$$

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

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

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

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

-----  
Calculation of Shear Strength at edge 2,  $V_{r2} = 558200.119$

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

-----  
NOTE: In expression (22.5.1.1) 'V<sub>w</sub>' is replaced by 'V<sub>w</sub> + f\*V<sub>f</sub>'  
where V<sub>f</sub> is the contribution of FRPs (11.3), ACI 440).

$$\text{From Table (22.5.5.1), ACI 318-14: } V_c = 209131.476$$

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

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

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

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

$$b_w = 400.00$$

$$d = 536.00$$

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

$$\mu_u = 1.0197E+006$$

$$V_u = 9840.633$$

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

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

$d = 536.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 150.00$

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

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

$d = 400.00$

$A_v = 100530.965$

$f_y = 555.56$

$s = 300.00$

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

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

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

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

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

At local axis: 3

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

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

-----  
Knowledge Factor, = 1.00

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

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

Jacket

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

Existing Column

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

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.03245

Element Length,  $L = 3000.00$

Primary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

## Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force,  $V_a = -6.9721474E-015$

EDGE -B-

Shear Force,  $V_b = 6.9721474E-015$

BOTH EDGES

Axial Force,  $F = -2237.255$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $As_t = 709.9999$

-Compression:  $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

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

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

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

Calculation of Shear Capacity ratio ,  $V_e/V_r = 0.53480887$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n / 2 = 204955.561$   
with

$M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 3.0743E+008$

$Mu_{1+} = 3.0743E+008$ , 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

$Mu_{1-} = 3.0743E+008$ , 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

$M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 3.0743E+008$

$Mu_{2+} = 3.0743E+008$ , 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

$Mu_{2-} = 3.0743E+008$ , 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

$V_1 = -6.9721474E-015$ , is the shear force acting at edge 1 for the the static loading combination

$V_2 = 6.9721474E-015$ , is the shear force acting at edge 2 for the the static loading combination

Calculation of  $Mu_{1+}$

Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

$\phi_u = 0.00010406$

$M_u = 3.0743E+008$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$f_c = 33.00$

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

Final value of  $\phi_{cu}$ :  $\phi_{cu}^* = \text{shear\_factor} \cdot \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00650345$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $\phi_{cu} = 0.00650345$

$w_e (5.4c) = 0.00563796$

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

$a_{se1} = 0.14776895$

$bo_1 = 340.00$

$ho_1 = 610.00$

$bi2_1 = 975400.00$

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

bo\_2 = 192.00  
ho\_2 = 492.00  
bi2\_2 = 557856.00  
psh,min\*Fywe = Min(psh,x\*Fywe , psh,y\*Fywe) = 1.25908

psh\_x\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 2.25223  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00261799  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 670.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00062519  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00156298  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 400.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00025008  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 200.00

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

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

y1 = 0.0025  
sh1 = 0.008  
ft1 = 833.34  
fy1 = 694.45  
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 = 694.45

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

y2 = 0.0025  
sh2 = 0.008  
ft2 = 833.34  
fy2 = 694.45  
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 = 694.45

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

yv = 0.0025  
shv = 0.008

$$ftv = 833.34$$

$$fyv = 694.45$$

$$suv = 0.032$$

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.

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

$$\text{with } fsv = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 694.45$$

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

$$1 = Asl_{ten} / (b * d) * (fs1 / fc) = 0.08015524$$

$$2 = Asl_{com} / (b * d) * (fs2 / fc) = 0.08015524$$

$$v = Asl_{mid} / (b * d) * (fsv / fc) = 0.04892233$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 34.07073$$

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

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

$$1 = Asl_{ten} / (b * d) * (fs1 / fc) = 0.09611636$$

$$2 = Asl_{com} / (b * d) * (fs2 / fc) = 0.09611636$$

$$v = Asl_{mid} / (b * d) * (fsv / fc) = 0.05866412$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

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

---->

$$su (4.9) = 0.13857861$$

$$Mu = MRc (4.14) = 3.0743E+008$$

$$u = su (4.1) = 0.00010406$$

-----  
Calculation of ratio  $lb/ld$

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

-----  
Calculation of  $Mu1$ -  
-----  
-----

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

$$u = 0.00010406$$

$$Mu = 3.0743E+008$$

-----  
with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$fc = 33.00$$

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

$$\text{Final value of } cu: cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } cu = 0.00650345$$

$$we (5.4c) = 0.00563796$$

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

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

ho\_1 = 610.00  
bi2\_1 = 975400.00  
ase2 = Max(ase1,ase2) = 0.14776895  
bo\_2 = 192.00  
ho\_2 = 492.00  
bi2\_2 = 557856.00  
psh,min\*Fywe = Min(psh,x\*Fywe , psh,y\*Fywe) = 1.25908

psh\_x\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 2.25223  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00261799  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 670.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00062519  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00156298  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 400.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00025008  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 200.00

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

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

y1 = 0.0025  
sh1 = 0.008  
ft1 = 833.34  
fy1 = 694.45  
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 = 694.45

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

y2 = 0.0025  
sh2 = 0.008  
ft2 = 833.34  
fy2 = 694.45  
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 = 694.45

with  $E_{s2} = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 200000.00$   
 $y_v = 0.0025$   
 $sh_v = 0.008$   
 $ft_v = 833.34$   
 $fy_v = 694.45$   
 $suv = 0.032$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $lo/lo_{min} = lb/ld = 1.00$   
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fs_yv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fs_yv = fsv/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 694.45$   
 with  $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.08015524$   
 $2 = A_{s,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.08015524$   
 $v = A_{s,mid} / (b \cdot d) \cdot (fsv / fc) = 0.04892233$

and confined core properties:

$b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.09611636$   
 $2 = A_{s,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.09611636$   
 $v = A_{s,mid} / (b \cdot d) \cdot (fsv / fc) = 0.05866412$

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

--->

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

--->

$su (4.9) = 0.13857861$   
 $Mu = MRc (4.14) = 3.0743E+008$   
 $u = su (4.1) = 0.00010406$

-----  
 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:

$u = 0.00010406$   
 $Mu = 3.0743E+008$

-----  
 with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $fc = 33.00$   
 $co (5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = \text{shear\_factor} \cdot \text{Max}(cu, cc) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00650345$   
 $we (5.4c) = 0.00563796$

ase ((5.4d), TBDY) = (ase1\*Aext+ase2\*Aint)/Asec = 0.14776895  
ase1 = 0.14776895  
bo\_1 = 340.00  
ho\_1 = 610.00  
bi\_2\_1 = 975400.00  
ase2 = Max(ase1,ase2) = 0.14776895  
bo\_2 = 192.00  
ho\_2 = 492.00  
bi\_2\_2 = 557856.00  
psh,min\*Fywe = Min(psh,x\*Fywe , psh,y\*Fywe) = 1.25908

psh\_x\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 2.25223  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00261799  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 670.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00062519  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00156298  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 400.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00025008  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 200.00

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

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

y1 = 0.0025  
sh1 = 0.008  
ft1 = 833.34  
fy1 = 694.45  
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 = 694.45

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

y2 = 0.0025  
sh2 = 0.008  
ft2 = 833.34  
fy2 = 694.45  
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  $f_{s2} = (f_{sjacket} \cdot A_{sl,com,jacket} + f_{s,core} \cdot A_{sl,com,core}) / A_{sl,com} = 694.45$

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

$y_v = 0.0025$

$sh_v = 0.008$

$ft_v = 833.34$

$fy_v = 694.45$

$suv = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor

and also multiplied by the shear\_factor according to 15.7.1.4, with

Shear\_factor = 1.00

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

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

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

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

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

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

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

with  $f_{sv} = (f_{sjacket} \cdot A_{sl,mid,jacket} + f_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 694.45$

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

1 =  $A_{sl,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.08015524$

2 =  $A_{sl,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.08015524$

v =  $A_{sl,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.04892233$

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

$f_{cc} (5A.2, TBDY) = 34.07073$

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

c = confinement factor = 1.03245

1 =  $A_{sl,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.09611636$

2 =  $A_{sl,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.09611636$

v =  $A_{sl,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.05866412$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

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

--->

$su (4.9) = 0.13857861$

$Mu = MRc (4.14) = 3.0743E+008$

u =  $su (4.1) = 0.00010406$

-----  
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 = 0.00010406

Mu = 3.0743E+008

-----  
with full section properties:

b = 670.00

d = 357.00

d' = 43.00

v = 0.00028344

N = 2237.255

$f_c = 33.00$

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

Final value of  $cu$ :  $cu^* = \text{shear\_factor} \cdot \text{Max}(cu, cc) = 0.00650345$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $c_u = 0.00650345$

$w_e$  (5.4c) = 0.00563796

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

$a_{se1} = 0.14776895$

$b_{o\_1} = 340.00$

$h_{o\_1} = 610.00$

$b_{i2\_1} = 975400.00$

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

$b_{o\_2} = 192.00$

$h_{o\_2} = 492.00$

$b_{i2\_2} = 557856.00$

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

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

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

$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$

No stirups,  $n_{s\_1} = 2.00$

$h_1 = 670.00$

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

$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$

No stirups,  $n_{s\_2} = 2.00$

$h_2 = 500.00$

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

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

$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$

No stirups,  $n_{s\_1} = 2.00$

$h_1 = 400.00$

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

$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$

No stirups,  $n_{s\_2} = 2.00$

$h_2 = 200.00$

$A_{sec} = 268000.00$

$s_1 = 150.00$

$s_2 = 300.00$

$f_{ywe1} = 694.45$

$f_{ywe2} = 694.45$

$f_{ce} = 33.00$

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

$c$  = confinement factor = 1.03245

$y_1 = 0.0025$

$sh_1 = 0.008$

$ft_1 = 833.34$

$fy_1 = 694.45$

$su_1 = 0.032$

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

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

$su_1 = 0.4 * e_{su1\_nominal}$  ((5.5), TBDY) = 0.032

From table 5A.1, TBDY:  $e_{su1\_nominal} = 0.08$ ,

For calculation of  $e_{su1\_nominal}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered characteristic value  $f_{sy1} = f_s / 1.2$ , from table 5.1, TBDY.

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

with  $f_{s1} = (f_{s, \text{jacket}} * A_{s1, \text{ten, jacket}} + f_{s, \text{core}} * A_{s1, \text{ten, core}}) / A_{s1, \text{ten}} = 694.45$

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

$y_2 = 0.0025$

$sh_2 = 0.008$

$ft_2 = 833.34$

$fy_2 = 694.45$

$su_2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor and also multiplied by the shear\_factor according to 15.7.1.4, with Shear\_factor = 1.00

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

$$su_2 = 0.4 * esu_2\_nominal ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY:  $esu_2\_nominal = 0.08$ ,

For calculation of  $esu_2\_nominal$  and  $y_2, sh_2, ft_2, fy_2$ , it is considered characteristic value  $fsy_2 = fs_2/1.2$ , from table 5.1, TBDY.

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

$$\text{with } fs_2 = (fs\_jacket * Asl,com,jacket + fs\_core * Asl,com,core) / Asl,com = 694.45$$

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

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 833.34$$

$$fy_v = 694.45$$

$$suv = 0.032$$

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

$$\text{with } fsv = (fs\_jacket * Asl,mid,jacket + fs\_mid * Asl,mid,core) / Asl,mid = 694.45$$

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

$$1 = Asl,ten / (b * d) * (fs_1 / fc) = 0.08015524$$

$$2 = Asl,com / (b * d) * (fs_2 / fc) = 0.08015524$$

$$v = Asl,mid / (b * d) * (fsv / fc) = 0.04892233$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 34.07073$$

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

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

$$1 = Asl,ten / (b * d) * (fs_1 / fc) = 0.09611636$$

$$2 = Asl,com / (b * d) * (fs_2 / fc) = 0.09611636$$

$$v = Asl,mid / (b * d) * (fsv / fc) = 0.05866412$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

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

--->

$$su (4.9) = 0.13857861$$

$$\mu_u = MRc (4.14) = 3.0743E+008$$

$$u = su (4.1) = 0.00010406$$

-----  
Calculation of ratio  $lb/ld$

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

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

-----  
Calculation of Shear Strength at edge 1,  $V_{r1} = 383231.42$

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

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

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

= 1 (normal-weight concrete)

Mean concrete strength:  $fc' = (fc'_jacket * Area\_jacket + fc'_core * Area\_core) / Area\_section = 33.00$ , but  $fc'^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)

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

As (tension reinf.) = 709.9999

bw = 670.00

d = 320.00

$V_u*d/\mu < 1 = 0.00$

$\mu = 8.6547052E-012$

$V_u = 6.9721474E-015$

From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$

$V_{s1} = 186169.943$  is calculated for jacket, with:

d = 320.00

$A_v = 157079.633$

$f_y = 555.56$

s = 150.00

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

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

d2 = 160.00

$A_v = 100530.965$

$f_y = 555.56$

s = 300.00

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

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

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

-----  
Calculation of Shear Strength at edge 2,  $V_{r2} = 383231.42$

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

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

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

= 1 (normal-weight concrete)

Mean concrete strength:  $f'_c = (f'_{c\_jacket}*Area\_jacket + f'_{c\_core}*Area\_core)/Area\_section = 33.00$ , but  $f'_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)

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

As (tension reinf.) = 709.9999

bw = 670.00

d = 320.00

$V_u*d/\mu < 1 = 0.00$

$\mu = 1.2266780E-011$

$V_u = 6.9721474E-015$

From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$

$V_{s1} = 186169.943$  is calculated for jacket, with:

d = 320.00

$A_v = 157079.633$

$f_y = 555.56$

s = 150.00

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

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

d = 160.00

$A_v = 100530.965$

$f_y = 555.56$

s = 300.00

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

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

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

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

At local axis: 2

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

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\phi = 1.00$   
 Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.  
 Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17  
 Consequently:  
 Jacket  
 New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$   
 New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$   
 Concrete Elasticity,  $E_c = 26999.444$   
 Steel Elasticity,  $E_s = 200000.00$   
 Existing Column  
 New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$   
 New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$   
 Concrete Elasticity,  $E_c = 26999.444$   
 Steel Elasticity,  $E_s = 200000.00$   
 External Height,  $H = 670.00$   
 External Width,  $W = 400.00$   
 Internal Height,  $H = 500.00$   
 Internal Width,  $W = 200.00$   
 Cover Thickness,  $c = 25.00$   
 Element Length,  $L = 3000.00$   
 Primary Member  
 Smooth Bars  
 Ductile Steel  
 With Detailing for Earthquake Resistance (including stirrups 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,  $M = 1.5895E+007$   
 Shear Force,  $V_2 = 8.4049242E-014$   
 Shear Force,  $V_3 = 18821.487$   
 Axial Force,  $F = -4363.489$   
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
 -Tension:  $A_{st} = 709.9999$   
 -Compression:  $A_{sc} = 1668.186$   
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
 -Tension:  $A_{st,ten} = 709.9999$   
 -Compression:  $A_{sc,com} = 1266.062$   
 -Middle:  $A_{sc,mid} = 402.1239$   
 Longitudinal External Reinforcement Area Distribution (in 3 divisions)  
 -Tension:  $A_{st,ten,jacket} = 402.1239$   
 -Compression:  $A_{sc,com,jacket} = 804.2477$   
 -Middle:  $A_{sc,mid,jacket} = 402.1239$   
 Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)  
 -Tension:  $A_{st,ten,core} = 307.8761$   
 -Compression:  $A_{sc,com,core} = 461.8141$   
 -Middle:  $A_{sc,mid,core} = 0.00$   
 Mean Diameter of Tension Reinforcement,  $Db_L = 15.00$

New component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u_R = 1.0^*$   $u = 0.01094898$   
 $u = y + p = 0.01094898$

- Calculation of  $y$  -

$y = (M_y * L_s / 3) / E_{eff} = 0.00094898$  ((4.29), Biskinis Phd)  
 $M_y = 2.7374E+008$   
 $L_s = M/V$  (with  $L_s > 0.1 * L$  and  $L_s < 2 * L$ ) = 844.5373  
 From table 10.5, ASCE 41\_17:  $E_{eff} = 0.3 * E_c * I_g = 8.1204E+013$

-----  
Calculation of Yielding Moment  $M_y$   
-----

Calculation of  $\rho_y$  and  $M_y$  according to Annex 7 -  
-----

$y = \text{Min}(y_{\text{ten}}, y_{\text{com}})$   
 $y_{\text{ten}} = 5.4349766\text{E-}006$   
with  $f_y = 555.56$   
 $d = 627.00$   
 $y = 0.18485333$   
 $A = 0.00951372$   
 $B = 0.00406512$   
with  $p_t = 0.00283094$   
 $p_c = 0.00504809$   
 $p_v = 0.00160336$   
 $N = 4363.489$   
 $b = 400.00$   
 $\rho = 0.06858054$   
 $y_{\text{comp}} = 1.9036374\text{E-}005$   
with  $f_c = 33.00$   
 $E_c = 26999.444$   
 $y = 0.18432314$   
 $A = 0.00944286$   
 $B = 0.0040338$   
with  $E_s = 200000.00$   
-----

Calculation of ratio  $l_b/d$   
-----

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

- Calculation of  $\rho$  -  
-----

From table 10-7:  $\rho = 0.01$

with:

- Condition i occurred

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

shear control ratio  $V_p/V_o = 0.90705729$

- Transverse Reinforcement: C

- Stirrup Spacing  $\leq d/3$

- Low ductility demand,  $\rho_y / \rho \leq 2$  (table 10-6, ASCE 41-17)

$\rho = 9.5960011\text{E-}006$

- Stirrup Spacing  $\leq d/2$

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

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

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

$V_s = 386302.632$ , already given in calculation of shear control ratio

design Shear = 18821.487

-  $(\rho - \rho') / \rho_{\text{bal}} = -0.22420649$

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

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:  $\rho_{\text{bal}} = 0.01704017$

$f_c = (f_{c_{\text{jacket}}} \cdot \text{Area}_{\text{jacket}} + f_{c_{\text{core}}} \cdot \text{Area}_{\text{core}}) / \text{section\_area} = 33.00$

$f_y = f_{y_{\text{jacket\_bars}}} = 555.56$

From 10.2.7.3, ACI 318-11:  $\rho_1 = 0.65$

From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + \rho_y) = 0.51922877$

$\rho_y = 0.0027778$

-  $V / (b_w \cdot d \cdot f_c^{0.5}) = 0.15732316$ , NOTE: units in lb & in

$b_w = 400.00$   
-----

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

At local axis: 2

Integration Section: (b)

## Calculation No. 7

beam B1, Floor 1

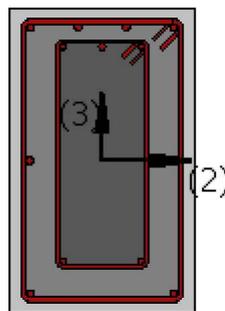
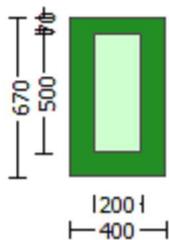
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity 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,  $\gamma = 1.00$

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

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

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$   
Element Length,  $L = 3000.00$   
Primary Member  
Smooth Bars  
Ductile Steel  
With Detailing for Earthquake Resistance (including stirrups closed at  $135^\circ$ )  
Longitudinal Bars With Ends Lapped Starting at the End Sections  
Adequate Lap Length ( $l_o/l_{o,u,min} = l_b/d \geq 1$ )  
No FRP Wrapping

-----  
Stepwise Properties  
-----

EDGE -A-  
Bending Moment,  $M_a = 1.1047E+007$   
Shear Force,  $V_a = 859.7793$   
EDGE -B-  
Bending Moment,  $M_b = 1.5895E+007$   
Shear Force,  $V_b = 18821.487$   
BOTH EDGES  
Axial Force,  $F = -4363.489$   
Longitudinal Reinforcement Area Distribution (in 2 divisions)  
-Tension:  $A_{st} = 709.9999$   
-Compression:  $A_{sc} = 1668.186$   
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $A_{st,ten} = 709.9999$   
-Compression:  $A_{sc,com} = 1266.062$   
-Middle:  $A_{st,mid} = 402.1239$   
Mean Diameter of Tension Reinforcement,  $D_{bL,ten} = 15.00$

-----  
New component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $V_R = 1.0 \cdot V_n = 493339.696$   
 $V_n$  ((22.5.1.1), ACI 318-14) = 493339.696  
-----

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

From Table (22.5.5.1), ACI 318-14:  $V_c = 179180.43$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f_c' = (f_c'_{jacket} \cdot Area_{jacket} + f_c'_{core} \cdot Area_{core}) / Area_{section} = 25.00$ , but  $f_c'^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / M_u < 1 = 0.63466702$   
 $M_u = 1.5895E+007$   
 $V_u = 18821.487$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 314159.265$   
 $V_{s1} = 280648.944$  is calculated for jacket, with:  
 $d = 536.00$   
 $A_v = 157079.633$   
 $f_y = 500.00$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 33510.322$  is calculated for core, with:  
 $d = 400.00$   
 $A_v = 100530.965$   
 $f_y = 500.00$   
 $s = 300.00$   
 $V_{s2}$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)  
 $2(1-s/d) = 0.50$   
 $V_f$  ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440:  $V_s + V_f \leq 712133.705$   
-----

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1  
At local axis: 3  
Integration Section: (b)

## Calculation No. 8

beam B1, Floor 1

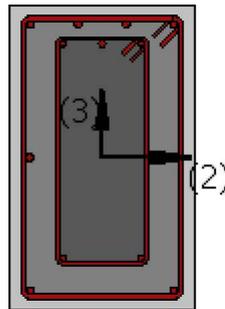
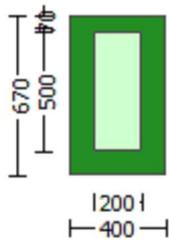
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (  $\theta$  )

Edge: End

Local Axis: (3)



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

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

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

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

Jacket

New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$   
 Existing Column  
 New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$   
 #####  
 External Height,  $H = 670.00$   
 External Width,  $W = 400.00$   
 Internal Height,  $H = 500.00$   
 Internal Width,  $W = 200.00$   
 Cover Thickness,  $c = 25.00$   
 Mean Confinement Factor overall section = 1.03245  
 Element Length,  $L = 3000.00$   
 Primary Member  
 Smooth Bars  
 Ductile Steel  
 With Detailing for Earthquake Resistance (including stirrups closed at 135°)  
 Longitudinal Bars With Ends Lapped Starting at the End Sections  
 Adequate Lap Length ( $l_o/l_{ou, \min} >= 1$ )  
 No FRP Wrapping

-----  
 Stepwise Properties  
 -----

At local axis: 3  
 EDGE -A-  
 Shear Force,  $V_a = 9840.633$   
 EDGE -B-  
 Shear Force,  $V_b = 9840.633$   
 BOTH EDGES  
 Axial Force,  $F = -2237.255$   
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
 -Tension:  $A_{st} = 709.9999$   
 -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 ,  $V_e/V_r = 0.90705729$   
 Member Controlled by Flexure ( $V_e/V_r < 1$ )  
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n / 2 = 506319.489$   
 with  
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 7.4472E+008$   
 $\mu_{u1+} = 4.3734E+008$ , 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  
 $\mu_{u1-} = 7.4472E+008$ , is the ultimate moment strength at the edge 1 of the member in the opposite moment  
 direction which is defined for the static loading combination  
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 7.4472E+008$   
 $\mu_{u2+} = 4.3734E+008$ , is the ultimate moment strength at the edge 2 of the member in the actual moment direction  
 which is defined for the the static loading combination  
 $\mu_{u2-} = 7.4472E+008$ , is the ultimate moment strength at the edge 2 of the member in the opposite moment  
 direction which is defined for the the static loading combination  
 and  
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$   
 with  
 $V_1 = 9840.633$ , is the shear force acting at edge 1 for the the static loading combination  
 $V_2 = 9840.633$ , is the shear force acting at edge 2 for the the static loading combination

-----  
 Calculation of  $\mu_{u1+}$   
 -----

-----  
 Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:  
 $\mu = 5.6088283E-005$

Mu = 4.3734E+008

with full section properties:

b = 400.00

d = 627.00

d' = 43.00

v = 0.00027032

N = 2237.255

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu:  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00650345$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $cu = 0.00650345$

we (5.4c) = 0.00563796

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

ase1 = 0.14776895

bo\_1 = 340.00

ho\_1 = 610.00

bi2\_1 = 975400.00

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

bo\_2 = 192.00

ho\_2 = 492.00

bi2\_2 = 557856.00

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

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

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

Ash1 =  $A_{stir\_1} * ns_1 = 157.0796$

No stirups, ns\_1 = 2.00

h1 = 670.00

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

Ash2 =  $A_{stir\_2} * ns_2 = 100.531$

No stirups, ns\_2 = 2.00

h2 = 500.00

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

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

Ash1 =  $A_{stir\_1} * ns_1 = 157.0796$

No stirups, ns\_1 = 2.00

h1 = 400.00

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

Ash2 =  $A_{stir\_2} * ns_2 = 100.531$

No stirups, ns\_2 = 2.00

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

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

c = confinement factor = 1.03245

y1 = 0.0025

sh1 = 0.008

ft1 = 833.34

fy1 = 694.45

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  $f_{s1} = (f_{s,jacket} \cdot A_{s,ten,jacket} + f_{s,core} \cdot A_{s,ten,core}) / A_{s,ten} = 694.45$   
 with  $E_{s1} = (E_{s,jacket} \cdot A_{s,ten,jacket} + E_{s,core} \cdot A_{s,ten,core}) / A_{s,ten} = 200000.00$   
 $y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$   
 $fy_2 = 694.45$   
 $su_2 = 0.032$   
 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  
 $l_0/l_{ou,min} = l_b/l_{b,min} = 1.00$   
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$   
 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  $f_{s2} = (f_{s,jacket} \cdot A_{s,com,jacket} + f_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 694.45$   
 with  $E_{s2} = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 200000.00$   
 $y_v = 0.0025$   
 $sh_v = 0.008$   
 $ft_v = 833.34$   
 $fy_v = 694.45$   
 $su_v = 0.032$   
 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  
 $l_0/l_{ou,min} = l_b/l_d = 1.00$   
 $su_v = 0.4 \cdot esu_{v,nominal} ((5.5), TBDY) = 0.032$   
 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  $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 694.45$   
 with  $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.05957415$   
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.10623177$   
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.03374111$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.0736092$   
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.13125889$   
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.04169017$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.09006517$   
 $M_u = M_{Rc} (4.14) = 4.3734E+008$   
 $u = su (4.1) = 5.6088283E-005$

-----  
 Calculation of ratio  $l_b/l_d$   
 -----

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

Calculation of  $M_{u1}$ -  
 -----

Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

$$u = 5.9367084E-005$$

$$Mu = 7.4472E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00650345$$

$$\phi_{we}(5.4c) = 0.00563796$$

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

$$a_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

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

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

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

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

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

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

$$su_1 = 0.4 * e_{su1\_nominal}((5.5), \text{TBDY}) = 0.032$$

From table 5A.1, TBDY:  $e_{su1\_nominal} = 0.08$ ,

For calculation of  $es_{u1\_nominal}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered characteristic value  $fs_{y1} = fs_1/1.2$ , 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  $fs_1 = (fs_{jacket} \cdot A_{s,ten,jacket} + fs_{core} \cdot A_{s,ten,core}) / A_{s,ten} = 694.45$

with  $Es_1 = (Es_{jacket} \cdot A_{s,ten,jacket} + Es_{core} \cdot A_{s,ten,core}) / A_{s,ten} = 200000.00$

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 833.34$$

$$fy_2 = 694.45$$

$$su_2 = 0.032$$

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

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

$$su_2 = 0.4 \cdot es_{u2\_nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY:  $es_{u2\_nominal} = 0.08$ ,

For calculation of  $es_{u2\_nominal}$  and  $y_2, sh_2, ft_2, fy_2$ , it is considered characteristic value  $fs_{y2} = fs_2/1.2$ , from table 5.1, TBDY.

$y_2, sh_2, ft_2, fy_2$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs_2 = (fs_{jacket} \cdot A_{s,com,jacket} + fs_{core} \cdot A_{s,com,core}) / A_{s,com} = 694.45$

with  $Es_2 = (Es_{jacket} \cdot A_{s,com,jacket} + Es_{core} \cdot A_{s,com,core}) / A_{s,com} = 200000.00$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 833.34$$

$$fy_v = 694.45$$

$$su_v = 0.032$$

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

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

$$su_v = 0.4 \cdot es_{uv\_nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY:  $es_{uv\_nominal} = 0.08$ ,

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

For calculation of  $es_{uv\_nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered characteristic value  $fs_{yv} = f_{sv}/1.2$ , from table 5.1, TBDY.

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

with  $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 694.45$

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

$$1 = A_{s,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.10623177$$

$$2 = A_{s,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.05957415$$

$$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / fc) = 0.03374111$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 34.07073$$

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

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

$$1 = A_{s,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.13125889$$

$$2 = A_{s,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.0736092$$

$$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / fc) = 0.04169017$$

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

--->

$$su (4.8) = 0.1403202$$

$$\mu = MR_c (4.15) = 7.4472E+008$$

$$u = su (4.1) = 5.9367084E-005$$

Calculation of ratio  $lb/ld$

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

Calculation of Mu2+

Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

$$\phi_u = 5.6088283E-005$$

$$M_u = 4.3734E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear\_factor} * \text{Max}(c_u, c_c) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00650345$$

$$w_e \text{ (5.4c)} = 0.00563796$$

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

$$a_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

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

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

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

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

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

with fs1 = (fs,jacket\*Asl,ten,jacket + fs,core\*Asl,ten,core)/Asl,ten = 694.45

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

y2 = 0.0025

sh2 = 0.008

ft2 = 833.34

fy2 = 694.45

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

with fs2 = (fs,jacket\*Asl,com,jacket + fs,core\*Asl,com,core)/Asl,com = 694.45

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

yv = 0.0025

shv = 0.008

ftv = 833.34

fyv = 694.45

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

with fsv = (fs,jacket\*Asl,mid,jacket + fs,mid\*Asl,mid,core)/Asl,mid = 694.45

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

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.05957415

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.10623177

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.03374111

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07073

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.0736092

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.13125889

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.04169017

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.09006517

Mu = MRc (4.14) = 4.3734E+008

u = su (4.1) = 5.6088283E-005

-----  
Calculation of ratio lb/d

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

Calculation of  $\mu_2$ -

Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:

$$\mu = 5.9367084E-005$$

$$\mu_2 = 7.4472E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu_c: \mu_c^* = \text{shear\_factor} * \text{Max}(\mu_c, c_c) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu_c = 0.00650345$$

$$w_e \text{ (5.4c)} = 0.00563796$$

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

$$a_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

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

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

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

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

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

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

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy1 = 694.45$$

$$su1 = 0.032$$

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.

$$\text{with } fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45$$

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

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 833.34$$

$$fy2 = 694.45$$

$$su2 = 0.032$$

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.

$$\text{with } fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45$$

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

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 833.34$$

$$fyv = 694.45$$

$$suv = 0.032$$

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.

$$\text{with } fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45$$

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

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.10623177$$

$$2 = Asl,com/(b*d)*(fs2/fc) = 0.05957415$$

$$v = Asl,mid/(b*d)*(fsv/fc) = 0.03374111$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 34.07073$$

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

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

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.13125889$$

$$2 = Asl,com/(b*d)*(fs2/fc) = 0.0736092$$

$$v = Asl,mid/(b*d)*(fsv/fc) = 0.04169017$$

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

---->

$$su (4.8) = 0.1403202$$

$$\begin{aligned} \mu &= MRC(4.15) = 7.4472E+008 \\ u &= su(4.1) = 5.9367084E-005 \end{aligned}$$

Calculation of ratio  $l_b/l_d$

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

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

Calculation of Shear Strength at edge 1,  $V_{r1} = 558200.119$   
 $V_{r1} = V_n$  ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'V<sub>w</sub>' is replaced by 'V<sub>w</sub> + f<sub>t</sub>V<sub>f</sub>'  
where V<sub>f</sub> is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot \text{Area}_{jacket} + f'_{c\_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$ , but  $f_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
A<sub>s</sub> (tension reinf.) = 709.9999  
b<sub>w</sub> = 400.00  
d = 536.00  
 $V_u \cdot d / \mu < 1 = 1.00$   
μ = 1.0197E+006  
V<sub>u</sub> = 9840.633  
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 349068.643$   
V<sub>s1</sub> = 311834.654 is calculated for jacket, with:  
d = 536.00  
A<sub>v</sub> = 157079.633  
f<sub>y</sub> = 555.56  
s = 150.00  
V<sub>s1</sub> has been multiplied by 1 (s < d/2, according to ASCE 41-17,10.3.4)  
V<sub>s2</sub> = 37233.989 is calculated for jacket, with:  
d<sub>2</sub> = 400.00  
A<sub>v</sub> = 100530.965  
f<sub>y</sub> = 555.56  
s = 300.00  
V<sub>s2</sub> 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<sub>f</sub> ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

Calculation of Shear Strength at edge 2,  $V_{r2} = 558200.119$   
 $V_{r2} = V_n$  ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'V<sub>w</sub>' is replaced by 'V<sub>w</sub> + f<sub>t</sub>V<sub>f</sub>'  
where V<sub>f</sub> is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot \text{Area}_{jacket} + f'_{c\_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$ , but  $f_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
A<sub>s</sub> (tension reinf.) = 709.9999  
b<sub>w</sub> = 400.00  
d = 536.00  
 $V_u \cdot d / \mu < 1 = 1.00$   
μ = 1.0197E+006  
V<sub>u</sub> = 9840.633  
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 349068.643$   
V<sub>s1</sub> = 311834.654 is calculated for jacket, with:  
d = 536.00

Av = 157079.633

fy = 555.56

s = 150.00

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

Vs2 = 37233.989 is calculated for jacket, with:

d = 400.00

Av = 100530.965

fy = 555.56

s = 300.00

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

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

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

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

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

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

Constant Properties

-----  
Knowledge Factor, = 1.00

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

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

Jacket

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

Existing Column

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

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.03245

Element Length,  $L = 3000.00$

Primary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

-----  
Stepwise Properties

-----  
At local axis: 2

EDGE -A-

Shear Force,  $V_a = -6.9721474E-015$

EDGE -B-

Shear Force,  $V_b = 6.9721474E-015$

BOTH EDGES

Axial Force,  $F = -2237.255$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $A_{st} = 709.9999$

-Compression:  $A_{sc} = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $A_{st,ten} = 911.0619$

-Compression:  $A_{sl,com} = 911.0619$

-Middle:  $A_{sl,mid} = 556.0619$

-----  
-----  
Calculation of Shear Capacity ratio ,  $V_e/V_r = 0.53480887$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n / 2 = 204955.561$

with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 3.0743E+008$

$M_{u1+} = 3.0743E+008$ , 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

$M_{u1-} = 3.0743E+008$ , 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

$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 3.0743E+008$

$M_{u2+} = 3.0743E+008$ , 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

$M_{u2-} = 3.0743E+008$ , 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

$V_1 = -6.9721474E-015$ , is the shear force acting at edge 1 for the the static loading combination

$V_2 = 6.9721474E-015$ , is the shear force acting at edge 2 for the the static loading combination

-----  
-----  
Calculation of  $M_{u1+}$

-----  
-----  
Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

$\phi_u = 0.00010406$

$M_u = 3.0743E+008$

-----  
-----  
with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$f_c = 33.00$

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

Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.00650345$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $\phi_u = 0.00650345$

$w_e$  (5.4c) = 0.00563796

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

$a_{se1} = 0.14776895$

$bo\_1 = 340.00$

$ho\_1 = 610.00$

$bi2\_1 = 975400.00$

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

$bo\_2 = 192.00$

$ho\_2 = 492.00$

$bi2\_2 = 557856.00$

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

$$psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25223$$
$$ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00261799$$
$$Ash1 = Astir_1*ns_1 = 157.0796$$
$$\text{No stirups, } ns_1 = 2.00$$
$$h1 = 670.00$$
$$ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00062519$$
$$Ash2 = Astir_2*ns_2 = 100.531$$
$$\text{No stirups, } ns_2 = 2.00$$
$$h2 = 500.00$$

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

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 694.45$$

$$fce = 33.00$$

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

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

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 833.34$$

$$fy1 = 694.45$$

$$su1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

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

$$su1 = 0.4*esu1\_nominal \text{ ((5.5), TBDY)} = 0.032$$

From table 5A.1, TBDY: esu1\_nominal = 0.08,

For calculation of esu1\_nominal and y1, sh1,ft1,fy1, it is considered  
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

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

$$\text{with } fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45$$

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

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 833.34$$

$$fy2 = 694.45$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

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

$$su2 = 0.4*esu2\_nominal \text{ ((5.5), TBDY)} = 0.032$$

From table 5A.1, TBDY: esu2\_nominal = 0.08,

For calculation of esu2\_nominal and y2, sh2,ft2,fy2, it is considered  
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

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

$$\text{with } fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45$$

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

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 833.34$$

$$fyv = 694.45$$

$$suv = 0.032$$

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

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

$s_{uv} = 0.4 * e_{suv\_nominal} ((5.5), TBDY) = 0.032$

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  $\gamma_v$ ,  $sh_v, ft_v, fy_v$ , it is considered  
characteristic value  $f_{sv} = f_{sv}/1.2$ , from table 5.1, TBDY.

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

with  $f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 694.45$

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

$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.08015524$

$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.08015524$

$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.04892233$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

$f_{cc} (5A.2, TBDY) = 34.07073$

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

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

$1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.09611636$

$2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.09611636$

$v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.05866412$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

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

--->

$s_u (4.9) = 0.13857861$

$M_u = MR_c (4.14) = 3.0743E+008$

$u = s_u (4.1) = 0.00010406$

Calculation of ratio  $l_b/l_d$

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

Calculation of  $M_u1$ -

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

$u = 0.00010406$

$M_u = 3.0743E+008$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$f_c = 33.00$

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

Final value of  $cu$ :  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00650345$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $cu = 0.00650345$

$w_e (5.4c) = 0.00563796$

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

$ase1 = 0.14776895$

$bo_1 = 340.00$

$ho_1 = 610.00$

$bi2_1 = 975400.00$

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

bo\_2 = 192.00  
ho\_2 = 492.00  
bi2\_2 = 557856.00  
psh,min\*Fywe = Min(psh,x\*Fywe , psh,y\*Fywe) = 1.25908

psh\_x\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 2.25223  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00261799  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 670.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00062519  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00156298  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 400.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00025008  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 200.00

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

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

y1 = 0.0025  
sh1 = 0.008  
ft1 = 833.34  
fy1 = 694.45  
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 = 694.45

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

y2 = 0.0025  
sh2 = 0.008  
ft2 = 833.34  
fy2 = 694.45  
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 = 694.45

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

yv = 0.0025  
shv = 0.008

$$ftv = 833.34$$

$$fyv = 694.45$$

$$suv = 0.032$$

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.

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

$$\text{with } fsv = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 694.45$$

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

$$1 = Asl_{ten} / (b * d) * (fs1 / fc) = 0.08015524$$

$$2 = Asl_{com} / (b * d) * (fs2 / fc) = 0.08015524$$

$$v = Asl_{mid} / (b * d) * (fsv / fc) = 0.04892233$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 34.07073$$

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

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

$$1 = Asl_{ten} / (b * d) * (fs1 / fc) = 0.09611636$$

$$2 = Asl_{com} / (b * d) * (fs2 / fc) = 0.09611636$$

$$v = Asl_{mid} / (b * d) * (fsv / fc) = 0.05866412$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

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

---->

$$su (4.9) = 0.13857861$$

$$Mu = MRc (4.14) = 3.0743E+008$$

$$u = su (4.1) = 0.00010406$$

-----  
Calculation of ratio  $lb/ld$

-----  
Adequate Lap Length:  $lb/ld \geq 1$   
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Calculation of  $Mu_{2+}$   
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Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:

$$u = 0.00010406$$

$$Mu = 3.0743E+008$$

-----  
with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$fc = 33.00$$

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

$$\text{Final value of } cu: cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } cu = 0.00650345$$

$$we (5.4c) = 0.00563796$$

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

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

ho\_1 = 610.00  
bi2\_1 = 975400.00  
ase2 = Max(ase1,ase2) = 0.14776895  
bo\_2 = 192.00  
ho\_2 = 492.00  
bi2\_2 = 557856.00  
psh,min\*Fywe = Min(psh,x\*Fywe , psh,y\*Fywe) = 1.25908

psh\_x\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 2.25223  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00261799  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 670.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00062519  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00156298  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 400.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00025008  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 200.00

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

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

y1 = 0.0025  
sh1 = 0.008  
ft1 = 833.34  
fy1 = 694.45  
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 = 694.45

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

y2 = 0.0025  
sh2 = 0.008  
ft2 = 833.34  
fy2 = 694.45  
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 = 694.45

with  $E_s2 = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 200000.00$   
 $y_v = 0.0025$   
 $sh_v = 0.008$   
 $ft_v = 833.34$   
 $fy_v = 694.45$   
 $suv = 0.032$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $lo/lo_{min} = lb/ld = 1.00$   
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 694.45$   
 with  $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.08015524$   
 $2 = A_{s,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.08015524$   
 $v = A_{s,mid} / (b \cdot d) \cdot (fsv / fc) = 0.04892233$

and confined core properties:

$b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.09611636$   
 $2 = A_{s,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.09611636$   
 $v = A_{s,mid} / (b \cdot d) \cdot (fsv / fc) = 0.05866412$

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

---

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

---

$su (4.9) = 0.13857861$   
 $Mu = MRc (4.14) = 3.0743E+008$   
 $u = su (4.1) = 0.00010406$

-----  
 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:

$u = 0.00010406$   
 $Mu = 3.0743E+008$

-----  
 with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $fc = 33.00$   
 $co (5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = \text{shear\_factor} \cdot \text{Max}(cu, cc) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00650345$   
 $we (5.4c) = 0.00563796$

ase ((5.4d), TBDY) = (ase1\*Aext+ase2\*Aint)/Asec = 0.14776895  
ase1 = 0.14776895  
bo\_1 = 340.00  
ho\_1 = 610.00  
bi2\_1 = 975400.00  
ase2 = Max(ase1,ase2) = 0.14776895  
bo\_2 = 192.00  
ho\_2 = 492.00  
bi2\_2 = 557856.00  
psh,min\*Fywe = Min(psh,x\*Fywe , psh,y\*Fywe) = 1.25908

psh\_x\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 2.25223  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00261799  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 670.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00062519  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00156298  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 400.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00025008  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 200.00

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

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

y1 = 0.0025  
sh1 = 0.008  
ft1 = 833.34  
fy1 = 694.45  
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 = 694.45

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

y2 = 0.0025  
sh2 = 0.008  
ft2 = 833.34  
fy2 = 694.45  
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.

$y_1, sh_1, ft_1, f_{y1}$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $f_{s2} = (f_{s,jacket} \cdot A_{s,com,jacket} + f_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 694.45$

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

$y_v = 0.0025$

$sh_v = 0.008$

$ft_v = 833.34$

$f_{y_v} = 694.45$

$s_{u_v} = 0.032$

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

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

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

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

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

For calculation of  $e_{s_{u_v,nominal}}$  and  $y_v, sh_v, ft_v, f_{y_v}$ , it is considered

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

$y_1, sh_1, ft_1, f_{y1}$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $f_{s_{y_v}} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 694.45$

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

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.08015524$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.08015524$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{s_{y_v}} / f_c) = 0.04892233$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

$f_{cc} (5A.2, TBDY) = 34.07073$

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

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

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.09611636$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.09611636$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{s_{y_v}} / f_c) = 0.05866412$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---

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

---

$s_u (4.9) = 0.13857861$

$\mu_u = M R_c (4.14) = 3.0743E+008$

$u = s_u (4.1) = 0.00010406$

Calculation of ratio  $l_b/l_d$

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

Calculation of Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 383231.42$

Calculation of Shear Strength at edge 1,  $V_{r1} = 383231.42$

$V_{r1} = V_n ((22.5.1.1), ACI 318-14)$

NOTE: In expression (22.5.1.1) ' $V_w$ ' is replaced by ' $V_w + f \cdot V_f$ '

where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 197061.477$

= 1 (normal-weight concrete)

Mean concrete strength:  $f'_c = (f'_{c,jacket} \cdot \text{Area}_{jacket} + f'_{c,core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$ , but  $f'_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$p_w = A_s / (b_w \cdot d) = 0.00331157$

$A_s$  (tension reinf.) = 709.9999

$b_w = 670.00$

$d = 320.00$

$$Vu*d/Mu < 1 = 0.00$$

$$Mu = 8.6547052E-012$$

$$Vu = 6.9721474E-015$$

From (11.5.4.8), ACI 318-14:  $Vs1 + Vs2 = 186169.943$

$Vs1 = 186169.943$  is calculated for jacket, with:

$$d = 320.00$$

$$Av = 157079.633$$

$$fy = 555.56$$

$$s = 150.00$$

$Vs1$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

$Vs2 = 0.00$  is calculated for jacket, with:

$$d2 = 160.00$$

$$Av = 100530.965$$

$$fy = 555.56$$

$$s = 300.00$$

$Vs2$  is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

$$Vf \text{ ((11-3)-(11.4), ACI 440)} = 0.00$$

$$\text{From (11-11), ACI 440: } Vs + Vf \leq 818179.336$$

Calculation of Shear Strength at edge 2,  $Vr2 = 383231.42$

$$Vr2 = Vn \text{ ((22.5.1.1), ACI 318-14)}$$

NOTE: In expression (22.5.1.1) ' $Vw$ ' is replaced by ' $Vw + f*Vf$ ' where  $Vf$  is the contribution of FRPs (11.3), ACI 440).

$$\text{From Table (22.5.5.1), ACI 318-14: } Vc = 197061.477$$

$$= 1 \text{ (normal-weight concrete)}$$

Mean concrete strength:  $fc' = (fc'_{\text{jacket}} * Area_{\text{jacket}} + fc'_{\text{core}} * Area_{\text{core}}) / Area_{\text{section}} = 33.00$ , but  $fc'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$$pw = As / (bw * d) = 0.00331157$$

$$As \text{ (tension reinf.)} = 709.9999$$

$$bw = 670.00$$

$$d = 320.00$$

$$Vu*d/Mu < 1 = 0.00$$

$$Mu = 1.2266780E-011$$

$$Vu = 6.9721474E-015$$

From (11.5.4.8), ACI 318-14:  $Vs1 + Vs2 = 186169.943$

$Vs1 = 186169.943$  is calculated for jacket, with:

$$d = 320.00$$

$$Av = 157079.633$$

$$fy = 555.56$$

$$s = 150.00$$

$Vs1$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

$Vs2 = 0.00$  is calculated for jacket, with:

$$d = 160.00$$

$$Av = 100530.965$$

$$fy = 555.56$$

$$s = 300.00$$

$Vs2$  is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

$$Vf \text{ ((11-3)-(11.4), ACI 440)} = 0.00$$

$$\text{From (11-11), ACI 440: } Vs + Vf \leq 818179.336$$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor, = 1.00

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups 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,  $M = -9.4153455E-011$

Shear Force,  $V_2 = 8.4049242E-014$

Shear Force,  $V_3 = 18821.487$

Axial Force,  $F = -4363.489$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $As_t = 709.9999$

-Compression:  $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{t,ten} = 911.0619$

-Compression:  $As_{c,com} = 911.0619$

-Middle:  $As_{mid} = 556.0619$

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{t,ten,jacket} = 603.1858$

-Compression:  $As_{c,com,jacket} = 603.1858$

-Middle:  $As_{mid,jacket} = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{t,ten,core} = 307.8761$

-Compression:  $As_{c,com,core} = 307.8761$

-Middle:  $As_{mid,core} = 153.938$

Mean Diameter of Tension Reinforcement,  $Db_L = 15.20$

-----  
New component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u_R = 1.0^*$   $u = 0.0084424$

$u = y + p = 0.0084424$

-----  
- Calculation of  $y$  -

$y = (M_y * L_s / 3) / E_{eff} = 0.0034424$  ((4.29), Biskinis Phd)

$M_y = 1.9927E+008$

$L_s = M/V$  (with  $L_s > 0.1 * L$  and  $L_s < 2 * L$ ) = 1500.00

From table 10.5, ASCE 41\_17:  $E_{eff} = 0.3 * E_c * I_g = 2.8943E+013$

-----  
Calculation of Yielding Moment  $M_y$

Calculation of  $\rho_y$  and  $M_y$  according to Annex 7 -

$y = \text{Min}(y_{\text{ten}}, y_{\text{com}})$   
 $y_{\text{ten}} = 1.0021098\text{E}-005$   
with  $f_y = 555.56$   
 $d = 357.00$   
 $y = 0.22354295$   
 $A = 0.0099755$   
 $B = 0.00560296$   
with  $p_t = 0.00380895$   
 $p_c = 0.00380895$   
 $p_v = 0.00232477$   
 $N = 4363.489$   
 $b = 670.00$   
 $\rho = 0.12044818$   
 $y_{\text{comp}} = 2.7617879\text{E}-005$   
with  $f_c = 33.00$   
 $E_c = 26999.444$   
 $y = 0.22313777$   
 $A = 0.0099012$   
 $B = 0.00557012$   
with  $E_s = 200000.00$

Calculation of ratio  $l_b/d$

Adequate Lap Length:  $l_b/d \geq 1$

- Calculation of  $\rho_p$  -

From table 10-7:  $\rho_p = 0.005$

with:

- Condition i occurred

Beam controlled by flexure:  $V_p/V_o \leq 1$

shear control ratio  $V_p/V_o = 0.53480887$

- Transverse Reinforcement: NC

- Stirrup Spacing  $> d/3$

- Low ductility demand,  $\rho_p / y < 2$  (table 10-6, ASCE 41-17)

$= 4.3544309\text{E}-022$

- Stirrup Spacing  $\leq d/2$

$d = d_{\text{external}} = 357.00$

$s = s_{\text{external}} = 150.00$

- Strength provided by hoops  $V_s < 3/4$  \* design Shear

$V_s = 215957.134$ , already given in calculation of shear control ratio

design Shear =  $8.4049242\text{E}-014$

- ( $\rho_p - \rho_p'$ ) /  $\rho_{\text{bal}} = -0.23508921$

$= A_{s1t}/(b_w*d) = 0.00296835$

Tension Reinf Area:  $A_{s1t} = 709.9999$

$\rho_p' = A_{s1c}/(b_w*d) = 0.00697431$

Compression Reinf Area:  $A_{s1c} = 1668.186$

From (B-1), ACI 318-11:  $\rho_{\text{bal}} = 0.01704017$

$f_c = (f_{c_{\text{jacket}}} * \text{Area}_{\text{jacket}} + f_{c_{\text{core}}} * \text{Area}_{\text{core}}) / \text{section\_area} = 33.00$

$f_y = f_{y_{\text{jacket\_bars}}} = 555.56$

From 10.2.7.3, ACI 318-11:  $\rho_p = 0.65$

From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + y) = 0.51922877$

$y = 0.0027778$

-  $V/(b_w*d*f_c^{0.5}) = 7.3664296\text{E}-019$ , NOTE: units in lb & in

$b_w = 670.00$

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)

## Calculation No. 9

beam B1, Floor 1

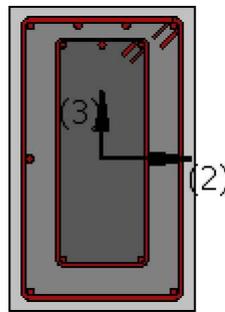
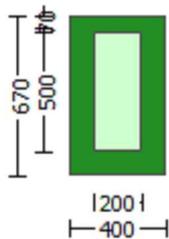
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Smooth Bars  
Ductile Steel  
With Detailing for Earthquake Resistance (including stirrups closed at 135°)  
Longitudinal Bars With Ends Lapped Starting at the End Sections  
Adequate Lap Length ( $l_o/l_{ou,min} = l_b/l_d \geq 1$ )  
No FRP Wrapping

-----  
Stepwise Properties  
-----

EDGE -A-  
Bending Moment,  $M_a = -1.0550018E-010$   
Shear Force,  $V_a = -5.6924552E-014$   
EDGE -B-  
Bending Moment,  $M_b = -6.5336195E-011$   
Shear Force,  $V_b = 5.6924552E-014$   
BOTH EDGES  
Axial Force,  $F = -3615.233$   
Longitudinal Reinforcement Area Distribution (in 2 divisions)  
-Tension:  $A_{sl,ten} = 709.9999$   
-Compression:  $A_{sl,com} = 1668.186$   
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $A_{sl,ten} = 911.0619$   
-Compression:  $A_{sl,com} = 911.0619$   
-Middle:  $A_{sl,mid} = 556.0619$   
Mean Diameter of Tension Reinforcement,  $Db_{L,ten} = 15.20$

-----  
New component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $V_R = 1.0 \cdot V_n = 339071.608$   
 $V_n$  ((22.5.1.1), ACI 318-14) = 339071.608  
-----

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f\*Vf'  
where Vf is the contribution of FRPs (11.3), ACI 440).  
-----

From Table (22.5.5.1), ACI 318-14:  $V_c = 171520.00$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c,jacket} \cdot Area_{jacket} + f'_{c,core} \cdot Area_{core}) / Area_{section} = 25.00$ , but  $f_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 1.0550018E-010$   
 $V_u = 5.6924552E-014$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 167551.608$   
 $V_{s1} = 167551.608$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 500.00$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 0.00$  is calculated for core, with:  
 $d = 160.00$   
 $A_v = 100530.965$   
 $f_y = 500.00$   
 $s = 300.00$   
 $V_{s2}$  is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)  
 $V_f$  ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440:  $V_s + V_f \leq 712133.705$   
-----

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1  
At local axis: 2  
Integration Section: (a)

## Calculation No. 10

beam B1, Floor 1

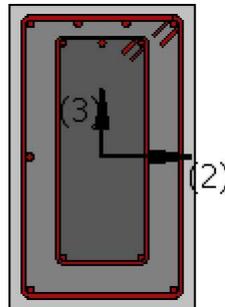
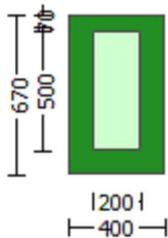
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (  $\theta$  )

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$

Existing Column

New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$

#####

External Height, H = 670.00  
External Width, W = 400.00  
Internal Height, H = 500.00  
Internal Width, W = 200.00  
Cover Thickness, c = 25.00  
Mean Confinement Factor overall section = 1.03245  
Element Length, L = 3000.00  
Primary Member  
Smooth Bars  
Ductile Steel  
With Detailing for Earthquake Resistance (including stirrups closed at 135°)  
Longitudinal Bars With Ends Lapped Starting at the End Sections  
Adequate Lap Length ( $l_o/l_{ou}, \min > = 1$ )  
No FRP Wrapping

-----  
Stepwise Properties  
-----

At local axis: 3  
EDGE -A-  
Shear Force,  $V_a = 9840.633$   
EDGE -B-  
Shear Force,  $V_b = 9840.633$   
BOTH EDGES  
Axial Force,  $F = -2237.255$   
Longitudinal Reinforcement Area Distribution (in 2 divisions)  
-Tension:  $A_{st} = 709.9999$   
-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:  $A_{sc,mid} = 402.1239$

-----  
-----  
Calculation of Shear Capacity ratio,  $V_e/V_r = 0.90705729$   
Member Controlled by Flexure ( $V_e/V_r < 1$ )  
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u * l_n / 2 = 506319.489$   
with  
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 7.4472E+008$   
 $Mu_{1+} = 4.3734E+008$ , 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  
 $Mu_{1-} = 7.4472E+008$ , 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  
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 7.4472E+008$   
 $Mu_{2+} = 4.3734E+008$ , 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  
 $Mu_{2-} = 7.4472E+008$ , 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  
 $V_1 = 9840.633$ , is the shear force acting at edge 1 for the the static loading combination  
 $V_2 = 9840.633$ , is the shear force acting at edge 2 for the the static loading combination

-----  
Calculation of  $Mu_{1+}$   
-----

-----  
Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:  
 $\phi_u = 5.6088283E-005$   
 $Mu = 4.3734E+008$

-----  
with full section properties:  
 $b = 400.00$

$d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$   
 $fc = 33.00$   
 $co (5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00650345$   
 $we (5.4c) = 0.00563796$   
 $ase ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo_1 = 340.00$   
 $ho_1 = 610.00$   
 $bi2_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo_2 = 192.00$   
 $ho_2 = 492.00$   
 $bi2_2 = 557856.00$   
 $psh, \min * F_{ywe} = \text{Min}(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.25908$

$psh, x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25223$   
 $ps1 (external) = (Ash1 * h1 / s1) / A_{sec} = 0.00261799$   
 $Ash1 = Astir_1 * ns_1 = 157.0796$   
 No stirups,  $ns_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 (internal) = (Ash2 * h2 / s2) / A_{sec} = 0.00062519$   
 $Ash2 = Astir_2 * ns_2 = 100.531$   
 No stirups,  $ns_2 = 2.00$   
 $h2 = 500.00$

$psh, y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25908$   
 $ps1 (external) = (Ash1 * h1 / s1) / A_{sec} = 0.00156298$   
 $Ash1 = Astir_1 * ns_1 = 157.0796$   
 No stirups,  $ns_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 (internal) = (Ash2 * h2 / s2) / A_{sec} = 0.00025008$   
 $Ash2 = Astir_2 * ns_2 = 100.531$   
 No stirups,  $ns_2 = 2.00$   
 $h2 = 200.00$

$A_{sec} = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fywe1 = 694.45$   
 $fywe2 = 694.45$   
 $fce = 33.00$

From ((5.A5), TBDY), TBDY:  $cc = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$

$y1 = 0.0025$   
 $sh1 = 0.008$   
 $ft1 = 833.34$   
 $fy1 = 694.45$   
 $su1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$

$lo/lou, \min = lb/ld = 1.00$   
 $su1 = 0.4 * esu1\_nominal ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,

For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered  
 characteristic value  $fsy1 = fs1 / 1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs1 = (fs, \text{jacket} * A_{sl, \text{ten, jacket}} + fs, \text{core} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 694.45$

with  $Es1 = (Es, \text{jacket} * A_{sl, \text{ten, jacket}} + Es, \text{core} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 200000.00$

$y2 = 0.0025$   
 $sh2 = 0.008$

$$ft2 = 833.34$$

$$fy2 = 694.45$$

$$su2 = 0.032$$

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  $\text{Min}(1, 1.25*(lb/d)^{2/3})$ , from 10.3.5, ASCE 41-17.

$$\text{with } fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45$$

$$\text{with } Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 833.34$$

$$fyv = 694.45$$

$$suv = 0.032$$

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  $\text{Min}(1, 1.25*(lb/d)^{2/3})$ , from 10.3.5, ASCE 41-17.

$$\text{with } fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45$$

$$\text{with } Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$$

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.05957415$$

$$2 = Asl,com/(b*d)*(fs2/fc) = 0.10623177$$

$$v = Asl,mid/(b*d)*(fsv/fc) = 0.03374111$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 34.07073$$

$$cc (5A.5, TBDY) = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.0736092$$

$$2 = Asl,com/(b*d)*(fs2/fc) = 0.13125889$$

$$v = Asl,mid/(b*d)*(fsv/fc) = 0.04169017$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

$v < vs,y2$  - LHS eq.(4.5) is satisfied

---->

$$su (4.9) = 0.09006517$$

$$Mu = MRc (4.14) = 4.3734E+008$$

$$u = su (4.1) = 5.6088283E-005$$

-----  
Calculation of ratio lb/d

-----  
Adequate Lap Length:  $lb/d \geq 1$   
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-----  
Calculation of Mu1-  
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-----  
Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 5.9367084E-005$$

$$Mu = 7.4472E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o (5A.5, TBDY) = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear\_factor} * \text{Max}(c_u, c_c) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00650345$$

$$w_e (5.4c) = 0.00563796$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$$

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.25223$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.25908$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A.5), TBDY), TBDY: } c_c = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

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

$$l_o / l_{o, \min} = l_b / d = 1.00$$

$$su_1 = 0.4 * esu_{1, \text{nominal}} ((5.5), TBDY) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu_{1, \text{nominal}} = 0.08,$$

For calculation of  $esu_{1, \text{nominal}}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered characteristic value  $fsy_1 = fs_1 / 1.2$ , from table 5.1, TBDY.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b / d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_1 = (fs_{\text{jacket}} * A_{sl, \text{ten, jacket}} + fs_{\text{core}} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 694.45$$

$$\text{with } Es1 = (Es_{\text{jacket}} \cdot Asl_{\text{ten,jacket}} + Es_{\text{core}} \cdot Asl_{\text{ten,core}}) / Asl_{\text{ten}} = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 833.34$$

$$fy2 = 694.45$$

$$su2 = 0.032$$
 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  

$$lo/lo_{\text{ou,min}} = lb/lb_{\text{min}} = 1.00$$

$$su2 = 0.4 \cdot esu2_{\text{nominal}} ((5.5), \text{TBDY}) = 0.032$$
 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.  

$$\text{with } fs2 = (fs_{\text{jacket}} \cdot Asl_{\text{com,jacket}} + fs_{\text{core}} \cdot Asl_{\text{com,core}}) / Asl_{\text{com}} = 694.45$$

$$\text{with } Es2 = (Es_{\text{jacket}} \cdot Asl_{\text{com,jacket}} + Es_{\text{core}} \cdot Asl_{\text{com,core}}) / Asl_{\text{com}} = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 833.34$$

$$fyv = 694.45$$

$$suv = 0.032$$
 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  

$$lo/lo_{\text{ou,min}} = lb/ld = 1.00$$

$$suv = 0.4 \cdot esuv_{\text{nominal}} ((5.5), \text{TBDY}) = 0.032$$
 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.  

$$\text{with } fsv = (fs_{\text{jacket}} \cdot Asl_{\text{mid,jacket}} + fs_{\text{mid}} \cdot Asl_{\text{mid,core}}) / Asl_{\text{mid}} = 694.45$$

$$\text{with } Esv = (Es_{\text{jacket}} \cdot Asl_{\text{mid,jacket}} + Es_{\text{mid}} \cdot Asl_{\text{mid,core}}) / Asl_{\text{mid}} = 200000.00$$

$$1 = Asl_{\text{ten}} / (b \cdot d) \cdot (fs1 / fc) = 0.10623177$$

$$2 = Asl_{\text{com}} / (b \cdot d) \cdot (fs2 / fc) = 0.05957415$$

$$v = Asl_{\text{mid}} / (b \cdot d) \cdot (fsv / fc) = 0.03374111$$
 and confined core properties:  

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, \text{TBDY}) = 34.07073$$

$$cc (5A.5, \text{TBDY}) = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = Asl_{\text{ten}} / (b \cdot d) \cdot (fs1 / fc) = 0.13125889$$

$$2 = Asl_{\text{com}} / (b \cdot d) \cdot (fs2 / fc) = 0.0736092$$

$$v = Asl_{\text{mid}} / (b \cdot d) \cdot (fsv / fc) = 0.04169017$$
 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  
 ---->  

$$su (4.8) = 0.1403202$$

$$Mu = MRc (4.15) = 7.4472E+008$$

$$u = su (4.1) = 5.9367084E-005$$

-----  
 Calculation of ratio  $lb/ld$

-----  
 Adequate Lap Length:  $lb/ld \geq 1$   
 -----  
 -----  
 -----

-----  
 Calculation of  $Mu2+$   
 -----

Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

$$u = 5.6088283E-005$$

$$\mu = 4.3734E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o(5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00650345$$

$$\phi_{we} \text{ (5.4c)} = 0.00563796$$

$$\text{ase ((5.4d), TBDY)} = (\text{ase1} * A_{ext} + \text{ase2} * A_{int}) / A_{sec} = 0.14776895$$

$$\text{ase1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

$$\text{ase2} = \text{Max}(\text{ase1}, \text{ase2}) = 0.14776895$$

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

$$\text{psh}_{\min} * F_{ywe} = \text{Min}(\text{psh}_{x} * F_{ywe}, \text{psh}_{y} * F_{ywe}) = 1.25908$$

$$\text{psh}_{x} * F_{ywe} = \text{psh1} * F_{ywe1} + \text{ps2} * F_{ywe2} = 2.25223$$

$$\text{ps1 (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

$$\text{ps2 (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

$$\text{psh}_{y} * F_{ywe} = \text{psh1} * F_{ywe1} + \text{ps2} * F_{ywe2} = 1.25908$$

$$\text{ps1 (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

$$\text{ps2 (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A.5), TBDY), TBDY: } \phi_{cc} = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

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

$$l_o / l_{o,\min} = l_b / d = 1.00$$

$$su_1 = 0.4 * e_{su1\_nominal} \text{ ((5.5), TBDY)} = 0.032$$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,

For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered characteristic value  $fsy1 = fs1/1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 694.45$

with  $Es1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$

$y2 = 0.0025$

$sh2 = 0.008$

$ft2 = 833.34$

$fy2 = 694.45$

$su2 = 0.032$

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  $fs2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 694.45$

with  $Es2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$

$yv = 0.0025$

$shv = 0.008$

$ftv = 833.34$

$fyv = 694.45$

$suv = 0.032$

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  $fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 694.45$

with  $Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$

$1 = A_{sl,ten} / (b * d) * (fs1 / fc) = 0.05957415$

$2 = A_{sl,com} / (b * d) * (fs2 / fc) = 0.10623177$

$v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.03374111$

and confined core properties:

$b = 340.00$

$d = 597.00$

$d' = 13.00$

$fcc (5A.2, TBDY) = 34.07073$

$cc (5A.5, TBDY) = 0.00232446$

$c = \text{confinement factor} = 1.03245$

$1 = A_{sl,ten} / (b * d) * (fs1 / fc) = 0.0736092$

$2 = A_{sl,com} / (b * d) * (fs2 / fc) = 0.13125889$

$v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.04169017$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < vs, y2$  - LHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.09006517$

$Mu = MRc (4.14) = 4.3734E+008$

$u = su (4.1) = 5.6088283E-005$

Calculation of ratio  $lb/ld$

Adequate Lap Length:  $lb/ld \geq 1$

Calculation of Mu2-

Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:

$$\mu = 5.9367084E-005$$

$$Mu = 7.4472E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear\_factor} * \text{Max}(c_u, c_c) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00650345$$

$$w_e \text{ (5.4c)} = 0.00563796$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i21} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i22} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$$

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.25223$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir, 1} * n_{s, 1} = 157.0796$$

$$\text{No stirups, } n_{s, 1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir, 2} * n_{s, 2} = 100.531$$

$$\text{No stirups, } n_{s, 2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.25908$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir, 1} * n_{s, 1} = 157.0796$$

$$\text{No stirups, } n_{s, 1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir, 2} * n_{s, 2} = 100.531$$

$$\text{No stirups, } n_{s, 2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

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 = 694.45

with Es1 = (Es,jacket\*Asl,ten,jacket + Es,core\*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025

sh2 = 0.008

ft2 = 833.34

fy2 = 694.45

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 = 694.45

with Es2 = (Es,jacket\*Asl,com,jacket + Es,core\*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 833.34

fyv = 694.45

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 = 694.45

with Esv = (Es,jacket\*Asl,mid,jacket + Es,mid\*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.10623177

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.05957415

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.03374111

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07073

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.13125889

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.0736092

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.04169017

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) = 0.1403202

Mu = MRc (4.15) = 7.4472E+008

u = su (4.1) = 5.9367084E-005

Calculation of ratio  $l_b/d$

Adequate Lap Length:  $l_b/d \geq 1$

Calculation of Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 558200.119$

Calculation of Shear Strength at edge 1,  $V_{r1} = 558200.119$   
 $V_{r1} = V_n$  ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' $V_w$ ' is replaced by ' $V_w + f \cdot V_f$ '  
where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot \text{Area}_{jacket} + f'_{c\_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$ , but  $f'_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / \mu < 1 = 1.00$   
 $\mu = 1.0197E+006$   
 $V_u = 9840.633$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 349068.643$   
 $V_{s1} = 311834.654$  is calculated for jacket, with:  
 $d = 536.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 37233.989$  is calculated for jacket, with:  
 $d_2 = 400.00$   
 $A_v = 100530.965$   
 $f_y = 555.56$   
 $s = 300.00$   
 $V_{s2}$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)  
 $2(1-s/d) = 0.50$   
 $V_f$  ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

Calculation of Shear Strength at edge 2,  $V_{r2} = 558200.119$   
 $V_{r2} = V_n$  ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' $V_w$ ' is replaced by ' $V_w + f \cdot V_f$ '  
where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot \text{Area}_{jacket} + f'_{c\_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$ , but  $f'_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / \mu < 1 = 1.00$   
 $\mu = 1.0197E+006$   
 $V_u = 9840.633$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 349068.643$   
 $V_{s1} = 311834.654$  is calculated for jacket, with:  
 $d = 536.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

Vs2 = 37233.989 is calculated for jacket, with:  
d = 400.00  
Av = 100530.965  
fy = 555.56  
s = 300.00  
Vs2 has been multiplied by 2(1-s/d) (s>d/2, according to ASCE 41-17,10.3.4)  
2(1-s/d) = 0.50  
Vf ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440: Vs + Vf <= 818179.336

-----  
End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1  
At local axis: 3  
-----

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1  
At Shear local axis: 2  
(Bending local axis: 3)  
Section Type: rcjars

Constant Properties

-----  
Knowledge Factor, = 1.00  
Mean strength values are used for both shear and moment calculations.  
Consequently:  
Jacket  
New material of Primary Member: Concrete Strength, fc = fcm = 33.00  
New material of Primary Member: Steel Strength, fs = fsm = 555.56  
Concrete Elasticity, Ec = 26999.444  
Steel Elasticity, Es = 200000.00  
Existing Column  
New material of Primary Member: Concrete Strength, fc = fcm = 33.00  
New material of Primary Member: Steel Strength, fs = fsm = 555.56  
Concrete Elasticity, Ec = 26999.444  
Steel Elasticity, Es = 200000.00  
#####  
Note: Especially for the calculation of moment strengths,  
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14  
Jacket  
New material: Steel Strength, fs = 1.25\*fsm = 694.45  
Existing Column  
New material: Steel Strength, fs = 1.25\*fsm = 694.45  
#####  
External Height, H = 670.00  
External Width, W = 400.00  
Internal Height, H = 500.00  
Internal Width, W = 200.00  
Cover Thickness, c = 25.00  
Mean Confinement Factor overall section = 1.03245  
Element Length, L = 3000.00  
Primary Member  
Smooth Bars  
Ductile Steel  
With Detailing for Earthquake Resistance (including stirrups closed at 135°)  
Longitudinal Bars With Ends Lapped Starting at the End Sections  
Adequate Lap Length (lo/lou,min>=1)  
No FRP Wrapping

-----  
Stepwise Properties

-----  
At local axis: 2  
EDGE -A-  
Shear Force, Va = -6.9721474E-015  
EDGE -B-  
Shear Force, Vb = 6.9721474E-015

BOTH EDGES

Axial Force,  $F = -2237.255$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $As_t = 709.9999$

-Compression:  $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{t,ten} = 911.0619$

-Compression:  $As_{c,com} = 911.0619$

-Middle:  $As_{mid} = 556.0619$

Calculation of Shear Capacity ratio,  $V_e/V_r = 0.53480887$

Member Controlled by Flexure ( $V_e/V_r < 1$ )

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 204955.561$   
with

$M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 3.0743E+008$

$Mu_{1+} = 3.0743E+008$ , 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

$Mu_{1-} = 3.0743E+008$ , 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

$M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 3.0743E+008$

$Mu_{2+} = 3.0743E+008$ , 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

$Mu_{2-} = 3.0743E+008$ , 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

$V_1 = -6.9721474E-015$ , is the shear force acting at edge 1 for the the static loading combination

$V_2 = 6.9721474E-015$ , is the shear force acting at edge 2 for the the static loading combination

Calculation of  $Mu_{1+}$

Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

$\phi_u = 0.00010406$

$M_u = 3.0743E+008$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$f_c = 33.00$

$\phi_c$  (5A.5, TBDY) = 0.002

Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00650345$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $\phi_u = 0.00650345$

$w_e$  (5.4c) = 0.00563796

$ase$  ((5.4d), TBDY) =  $(ase_1 \cdot A_{ext} + ase_2 \cdot A_{int})/A_{sec} = 0.14776895$

$ase_1 = 0.14776895$

$bo_1 = 340.00$

$ho_1 = 610.00$

$bi_2_1 = 975400.00$

$ase_2 = \text{Max}(ase_1, ase_2) = 0.14776895$

$bo_2 = 192.00$

$ho_2 = 492.00$

$bi_2_2 = 557856.00$

$psh_{min} \cdot F_{ywe} = \text{Min}(psh_x \cdot F_{ywe}, psh_y \cdot F_{ywe}) = 1.25908$

$psh_x \cdot F_{ywe} = psh_1 \cdot F_{ywe1} + ps_2 \cdot F_{ywe2} = 2.25223$

$ps_1$  (external) =  $(A_{sh1} \cdot h_1/s_1)/A_{sec} = 0.00261799$

Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 670.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00062519  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00156298  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 400.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00025008  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 200.00

Asec = 268000.00  
s1 = 150.00  
s2 = 300.00  
fywe1 = 694.45  
fywe2 = 694.45  
fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.00232446  
c = confinement factor = 1.03245

y1 = 0.0025  
sh1 = 0.008  
ft1 = 833.34  
fy1 = 694.45  
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 = 694.45

with Es1 = (Es,jacket\*Asl,ten,jacket + Es,core\*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025  
sh2 = 0.008  
ft2 = 833.34  
fy2 = 694.45  
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 = 694.45

with Es2 = (Es,jacket\*Asl,com,jacket + Es,core\*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025  
shv = 0.008  
ftv = 833.34  
fyv = 694.45  
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  $fsv = fsv/1.2$ , 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.

$y1, sh1,ft1,fy1$ , are also multiplied by  $Min(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

$$\text{with } fsv = (fs\_jacket * Asl\_mid\_jacket + fs\_mid * Asl\_mid\_core) / Asl\_mid = 694.45$$

$$\text{with } Esv = (Es\_jacket * Asl\_mid\_jacket + Es\_mid * Asl\_mid\_core) / Asl\_mid = 200000.00$$

$$1 = Asl\_ten / (b * d) * (fs1 / fc) = 0.08015524$$

$$2 = Asl\_com / (b * d) * (fs2 / fc) = 0.08015524$$

$$v = Asl\_mid / (b * d) * (fsv / fc) = 0.04892233$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 34.07073$$

$$cc (5A.5, TBDY) = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = Asl\_ten / (b * d) * (fs1 / fc) = 0.09611636$$

$$2 = Asl\_com / (b * d) * (fs2 / fc) = 0.09611636$$

$$v = Asl\_mid / (b * d) * (fsv / fc) = 0.05866412$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

$v < vs,c$  - RHS eq.(4.5) is satisfied

--->

$$su (4.9) = 0.13857861$$

$$Mu = MRc (4.14) = 3.0743E+008$$

$$u = su (4.1) = 0.00010406$$

Calculation of ratio  $lb/ld$

Adequate Lap Length:  $lb/ld \geq 1$

Calculation of  $Mu1$ -

Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:

$$u = 0.00010406$$

$$Mu = 3.0743E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$fc = 33.00$$

$$co (5A.5, TBDY) = 0.002$$

$$\text{Final value of } cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } cu = 0.00650345$$

$$we (5.4c) = 0.00563796$$

$$ase ((5.4d), TBDY) = (ase1 * Aext + ase2 * Aint) / Asec = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo\_1 = 340.00$$

$$ho\_1 = 610.00$$

$$bi2\_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo\_2 = 192.00$$

$$ho\_2 = 492.00$$

$$bi2\_2 = 557856.00$$

$$psh\_min * Fywe = \text{Min}(psh,x * Fywe, psh,y * Fywe) = 1.25908$$

psh\_x\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 2.25223  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00261799  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 670.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00062519  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00156298  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 400.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00025008  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00232446

c = confinement factor = 1.03245

y1 = 0.0025

sh1 = 0.008

ft1 = 833.34

fy1 = 694.45

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  $\text{Min}(1, 1.25 * (\text{lb}/\text{ld})^{2/3})$ , from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket\*Asl,ten,jacket + fs,core\*Asl,ten,core)/Asl,ten = 694.45

with Es1 = (Es,jacket\*Asl,ten,jacket + Es,core\*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025

sh2 = 0.008

ft2 = 833.34

fy2 = 694.45

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  $\text{Min}(1, 1.25 * (\text{lb}/\text{ld})^{2/3})$ , from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket\*Asl,com,jacket + fs,core\*Asl,com,core)/Asl,com = 694.45

with Es2 = (Es,jacket\*Asl,com,jacket + Es,core\*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 833.34

fyv = 694.45

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<sub>u,min</sub> = lb/d = 1.00

su<sub>v</sub> = 0.4\*esuv\_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv\_nominal = 0.08,

considering characteristic value fs<sub>yv</sub> = fsv/1.2, from table 5.1, TBDY

For calculation of esuv\_nominal and y<sub>v</sub>, sh<sub>v</sub>,ft<sub>v</sub>,fy<sub>v</sub>, it is considered characteristic value fs<sub>yv</sub> = fsv/1.2, from table 5.1, TBDY.

y<sub>1</sub>, sh<sub>1</sub>,ft<sub>1</sub>,fy<sub>1</sub>, are also multiplied by Min(1,1.25\*(lb/d)<sup>2/3</sup>), from 10.3.5, ASCE 41-17.

with fsv = (fs<sub>jacket</sub>\*As<sub>l,mid,jacket</sub> + fs<sub>mid</sub>\*As<sub>l,mid,core</sub>)/As<sub>l,mid</sub> = 694.45

with Es<sub>v</sub> = (Es<sub>jacket</sub>\*As<sub>l,mid,jacket</sub> + Es<sub>mid</sub>\*As<sub>l,mid,core</sub>)/As<sub>l,mid</sub> = 200000.00

1 = As<sub>l,ten</sub>/(b\*d)\*(fs<sub>1</sub>/fc) = 0.08015524

2 = As<sub>l,com</sub>/(b\*d)\*(fs<sub>2</sub>/fc) = 0.08015524

v = As<sub>l,mid</sub>/(b\*d)\*(fsv/fc) = 0.04892233

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07073

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = As<sub>l,ten</sub>/(b\*d)\*(fs<sub>1</sub>/fc) = 0.09611636

2 = As<sub>l,com</sub>/(b\*d)\*(fs<sub>2</sub>/fc) = 0.09611636

v = As<sub>l,mid</sub>/(b\*d)\*(fsv/fc) = 0.05866412

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

v < v<sub>s,c</sub> - RHS eq.(4.5) is satisfied

--->

su (4.9) = 0.13857861

Mu = MRc (4.14) = 3.0743E+008

u = su (4.1) = 0.00010406

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu<sub>2+</sub>

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 0.00010406

Mu = 3.0743E+008

with full section properties:

b = 670.00

d = 357.00

d' = 43.00

v = 0.00028344

N = 2237.255

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu: cu\* = shear\_factor \* Max( cu, cc) = 0.00650345

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.00650345

we (5.4c) = 0.00563796

ase ((5.4d), TBDY) = (ase1\*Aext+ase2\*Aint)/Asec = 0.14776895

ase1 = 0.14776895

bo<sub>1</sub> = 340.00

ho<sub>1</sub> = 610.00

bi<sub>2,1</sub> = 975400.00

ase2 = Max(ase1,ase2) = 0.14776895

bo<sub>2</sub> = 192.00

ho\_2 = 492.00  
bi2\_2 = 557856.00  
psh,min\*Fywe = Min(psh,x\*Fywe , psh,y\*Fywe) = 1.25908

psh\_x\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 2.25223  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00261799  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 670.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00062519  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00156298  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 400.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00025008  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 200.00

Asec = 268000.00  
s1 = 150.00  
s2 = 300.00  
fywe1 = 694.45  
fywe2 = 694.45  
fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.00232446  
c = confinement factor = 1.03245

y1 = 0.0025  
sh1 = 0.008  
ft1 = 833.34  
fy1 = 694.45  
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 = 694.45

with Es1 = (Es,jacket\*Asl,ten,jacket + Es,core\*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025  
sh2 = 0.008  
ft2 = 833.34  
fy2 = 694.45  
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 fs2 = (fs,jacket\*Asl,com,jacket + fs,core\*Asl,com,core)/Asl,com = 694.45

with Es2 = (Es,jacket\*Asl,com,jacket + Es,core\*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025  
shv = 0.008  
ftv = 833.34

$f_{yv} = 694.45$   
 $s_{uv} = 0.032$   
 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  $f_{sv} = (f_{s,jacket} * A_{sl,mid,jacket} + f_{s,mid} * A_{sl,mid,core}) / A_{sl,mid} = 694.45$   
 with  $E_{sv} = (E_{s,jacket} * A_{sl,mid,jacket} + E_{s,mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$   
 $1 = A_{sl,ten} / (b * d) * (f_{s1} / f_c) = 0.08015524$   
 $2 = A_{sl,com} / (b * d) * (f_{s2} / f_c) = 0.08015524$   
 $v = A_{sl,mid} / (b * d) * (f_{sv} / f_c) = 0.04892233$   
 and confined core properties:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = A_{sl,ten} / (b * d) * (f_{s1} / f_c) = 0.09611636$   
 $2 = A_{sl,com} / (b * d) * (f_{s2} / f_c) = 0.09611636$   
 $v = A_{sl,mid} / (b * d) * (f_{sv} / f_c) = 0.05866412$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' does not satisfy Eq. (4.3)  
 --->  
 $v < v_{s,c}$  - RHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.13857861$   
 $Mu = MRc (4.14) = 3.0743E+008$   
 $u = su (4.1) = 0.00010406$

-----  
 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:

$u = 0.00010406$   
 $Mu = 3.0743E+008$   
 -----

with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $co (5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00650345$   
 $w_e (5.4c) = 0.00563796$   
 $ase ((5.4d), TBDY) = (ase_1 * A_{ext} + ase_2 * A_{int}) / A_{sec} = 0.14776895$   
 $ase_1 = 0.14776895$   
 $bo_1 = 340.00$   
 $ho_1 = 610.00$

bi2\_1 = 975400.00  
ase2 = Max(ase1,ase2) = 0.14776895  
bo\_2 = 192.00  
ho\_2 = 492.00  
bi2\_2 = 557856.00  
psh,min\*Fywe = Min(psh,x\*Fywe , psh,y\*Fywe) = 1.25908

psh\_x\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 2.25223  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00261799  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 670.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00062519  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00156298  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 400.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00025008  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 200.00

Asec = 268000.00  
s1 = 150.00  
s2 = 300.00  
fywe1 = 694.45  
fywe2 = 694.45  
fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00232446  
c = confinement factor = 1.03245

y1 = 0.0025  
sh1 = 0.008  
ft1 = 833.34  
fy1 = 694.45  
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 = 694.45

with Es1 = (Es,jacket\*Asl,ten,jacket + Es,core\*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025  
sh2 = 0.008  
ft2 = 833.34  
fy2 = 694.45  
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 = 694.45

with Es2 = (Es,jacket\*Asl,com,jacket + Es,core\*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025  
shv = 0.008  
ftv = 833.34  
fyv = 694.45  
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 = 694.45

with Esv = (Es,jacket\*Asl,mid,jacket + Es,mid\*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.08015524

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.08015524

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.04892233

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07073

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.09611636

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.09611636

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.05866412

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) = 0.13857861

Mu = MRc (4.14) = 3.0743E+008

u = su (4.1) = 0.00010406

-----  
Calculation of ratio lb/ld

-----  
Adequate Lap Length: lb/ld >= 1  
-----  
-----  
-----

-----  
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 383231.42  
-----

-----  
Calculation of Shear Strength at edge 1, Vr1 = 383231.42

Vr1 = Vn ((22.5.1.1), ACI 318-14)

-----  
NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f\*Vf'  
where Vf is the contribution of FRPs (11.3), ACI 440).

-----  
From Table (22.5.5.1), ACI 318-14: Vc = 197061.477

= 1 (normal-weight concrete)

Mean concrete strength: fc' = (fc'\_jacket\*Area\_jacket + fc'\_core\*Area\_core)/Area\_section = 33.00, but  $fc'^{0.5} \leq 8.3$   
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 = 8.6547052E-012

Vu = 6.9721474E-015

From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 186169.943

Vs1 = 186169.943 is calculated for jacket, with:

d = 320.00

Av = 157079.633

fy = 555.56

s = 150.00

Vs1 has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

Vs2 = 0.00 is calculated for jacket, with:

d2 = 160.00

Av = 100530.965

fy = 555.56

s = 300.00

Vs2 is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

Calculation of Shear Strength at edge 2, Vr2 = 383231.42

Vr2 = Vn ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f\*Vf' where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: Vc = 197061.477

= 1 (normal-weight concrete)

Mean concrete strength:  $f_c' = (f_c'_{\text{jacket}} * \text{Area}_{\text{jacket}} + f_c'_{\text{core}} * \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 33.00$ , but  $f_c'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

pw =  $A_s / (b_w * d) = 0.00331157$

As (tension reinf.) = 709.9999

bw = 670.00

d = 320.00

$V_u * d / \mu_u < 1 = 0.00$

$\mu_u = 1.2266780E-011$

$V_u = 6.9721474E-015$

From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 186169.943

Vs1 = 186169.943 is calculated for jacket, with:

d = 320.00

Av = 157079.633

fy = 555.56

s = 150.00

Vs1 has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

Vs2 = 0.00 is calculated for jacket, with:

d = 160.00

Av = 100530.965

fy = 555.56

s = 300.00

Vs2 is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, = 1.00

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$   
 Concrete Elasticity,  $E_c = 26999.444$   
 Steel Elasticity,  $E_s = 200000.00$   
 Existing Column  
 New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$   
 New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$   
 Concrete Elasticity,  $E_c = 26999.444$   
 Steel Elasticity,  $E_s = 200000.00$   
 External Height,  $H = 670.00$   
 External Width,  $W = 400.00$   
 Internal Height,  $H = 500.00$   
 Internal Width,  $W = 200.00$   
 Cover Thickness,  $c = 25.00$   
 Element Length,  $L = 3000.00$   
 Primary Member  
 Smooth Bars  
 Ductile Steel  
 With Detailing for Earthquake Resistance (including stirrups 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,  $M = 6.8008E+006$   
 Shear Force,  $V_2 = -5.6924552E-014$   
 Shear Force,  $V_3 = 4020.289$   
 Axial Force,  $F = -3615.233$   
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
   -Tension:  $A_{st} = 709.9999$   
   -Compression:  $A_{sc} = 1668.186$   
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $A_{st,ten} = 709.9999$   
   -Compression:  $A_{sc,com} = 1266.062$   
   -Middle:  $A_{sc,mid} = 402.1239$   
 Longitudinal External Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $A_{st,ten,jacket} = 402.1239$   
   -Compression:  $A_{sc,com,jacket} = 804.2477$   
   -Middle:  $A_{sc,mid,jacket} = 402.1239$   
 Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $A_{st,ten,core} = 307.8761$   
   -Compression:  $A_{sc,com,core} = 461.8141$   
   -Middle:  $A_{sc,mid,core} = 0.00$   
 Mean Diameter of Tension Reinforcement,  $DbL = 15.00$   
 -----  
 -----

New component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u_{,R} = 1.0^*$   $u = 0.05189937$   
 $u = y + p = 0.05189937$

-----  
 - Calculation of  $y$  -  
 -----

$y = (M_y * L_s / 3) / E_{eff} = 0.00189937$  ((4.29), Biskinis Phd))  
 $M_y = 2.7353E+008$   
 $L_s = M/V$  (with  $L_s > 0.1 * L$  and  $L_s < 2 * L$ ) = 1691.607  
 From table 10.5, ASCE 41\_17:  $E_{eff} = 0.3 * E_c * I_g = 8.1204E+013$   
 -----  
 -----

Calculation of Yielding Moment  $M_y$   
 -----

Calculation of  $y$  and  $M_y$  according to Annex 7 -  
 -----

$y = \text{Min}(y_{ten}, y_{com})$

$y_{ten} = 5.4341296E-006$   
 with  $f_y = 555.56$   
 $d = 627.00$   
 $y = 0.18472628$   
 $A = 0.00950835$   
 $B = 0.00405975$   
 with  $pt = 0.00283094$   
 $pc = 0.00504809$   
 $pv = 0.00160336$   
 $N = 3615.233$   
 $b = 400.00$   
 $" = 0.06858054$   
 $y_{comp} = 1.9040134E-005$   
 with  $f_c = 33.00$   
 $E_c = 26999.444$   
 $y = 0.18428673$   
 $A = 0.00944964$   
 $B = 0.0040338$   
 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:  $p = 0.05$

with:

- Condition i occurred

Beam controlled by flexure:  $V_p/V_o \leq 1$

shear control ratio  $V_p/V_o = 0.90705729$

- Transverse Reinforcement: C

- Stirrup Spacing  $\leq d/3$

- Low ductility demand,  $\lambda / y < 2$  (table 10-6, ASCE 41-17)

$= 4.7230116E-005$

- Stirrup Spacing  $\leq d/2$

$d = d_{external} = 627.00$

$s = s_{external} = 150.00$

- Strength provided by hoops  $V_s < 3/4 * \text{design Shear}$

$V_s = 386302.632$ , already given in calculation of shear control ratio

design Shear = 4020.289

- ( $\lambda - \lambda'$ )/  $bal = -0.22420649$

$= A_{slt}/(b_w*d) = 0.00283094$

Tension Reinf Area:  $A_{slt} = 709.9999$

$\lambda' = A_{slc}/(b_w*d) = 0.00665146$

Compression Reinf Area:  $A_{slc} = 1668.186$

From (B-1), ACI 318-11:  $bal = 0.01704017$

$f_c = (f_{c\_jacket} * \text{Area}_{jacket} + f_{c\_core} * \text{Area}_{core}) / \text{section\_area} = 33.00$

$f_y = f_{y\_jacket\_bars} = 555.56$

From 10.2.7.3, ACI 318-11:  $\lambda = 0.65$

From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + y) = 0.51922877$

$y = 0.0027778$

-  $V/(b_w*d*f_c^{0.5}) = 0.03360439$ , 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

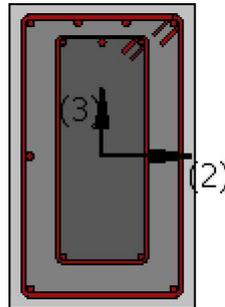
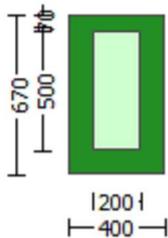
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity  $V_{Rd}$

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups closed at  $135^\circ$ )

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,  $M_a = 6.8008E+006$

Shear Force,  $V_a = 4020.289$

EDGE -B-

Bending Moment,  $M_b = 1.0660E+007$

Shear Force,  $V_b = 15660.977$

BOTH EDGES

Axial Force,  $F = -3615.233$

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:  $As_{t, \text{ten}} = 709.9999$

-Compression:  $As_{c, \text{com}} = 1266.062$

-Middle:  $As_{c, \text{mid}} = 402.1239$

Mean Diameter of Tension Reinforcement,  $Db_{L, \text{ten}} = 15.00$

-----  
New component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $V_R = 1.0 \cdot V_n = 489503.746$

$V_n$  ((22.5.1.1), ACI 318-14) = 489503.746

-----  
NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw + f\*Vf'  
where Vf is the contribution of FRPs (11.3), ACI 440).

-----  
From Table (22.5.5.1), ACI 318-14:  $V_c = 175344.48$

= 1 (normal-weight concrete)

Mean concrete strength:  $f'_c = (f'_{c, \text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_{c, \text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 25.00$ , but  $f'_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)

$\rho_w = A_s / (b_w \cdot d) = 0.00331157$

$A_s$  (tension reinf.) = 709.9999

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / M_u < 1 = 0.31685838$

$M_u = 6.8008E+006$

$V_u = 4020.289$

From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 314159.265$

$V_{s1} = 280648.944$  is calculated for jacket, with:

$d = 536.00$

$A_v = 157079.633$

$f_y = 500.00$

$s = 150.00$

$V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

$V_{s2} = 33510.322$  is calculated for core, with:

$d = 400.00$

$A_v = 100530.965$

$f_y = 500.00$

$s = 300.00$

$V_{s2}$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

$V_f$  ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440:  $V_s + V_f \leq 712133.705$

-----  
End Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

## Calculation No. 12

beam B1, Floor 1

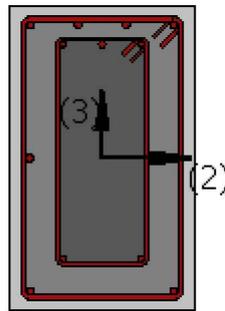
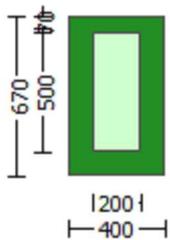
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity ( $\theta_r$ )

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$

Existing Column

New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$   
Mean Confinement Factor overall section = 1.03245  
Element Length,  $L = 3000.00$   
Primary Member  
Smooth Bars  
Ductile Steel  
With Detailing for Earthquake Resistance (including stirrups closed at  $135^\circ$ )  
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,  $V_a = 9840.633$   
EDGE -B-  
Shear Force,  $V_b = 9840.633$   
BOTH EDGES  
Axial Force,  $F = -2237.255$   
Longitudinal Reinforcement Area Distribution (in 2 divisions)  
-Tension:  $A_{st} = 709.9999$   
-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,  $V_e/V_r = 0.90705729$   
Member Controlled by Flexure ( $V_e/V_r < 1$ )  
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 506319.489$   
with  
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 7.4472E+008$   
 $\mu_{u1+} = 4.3734E+008$ , 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  
 $\mu_{u1-} = 7.4472E+008$ , is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination  
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 7.4472E+008$   
 $\mu_{u2+} = 4.3734E+008$ , 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  
 $\mu_{u2-} = 7.4472E+008$ , is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination  
and  
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$   
with  
 $V_1 = 9840.633$ , is the shear force acting at edge 1 for the static loading combination  
 $V_2 = 9840.633$ , is the shear force acting at edge 2 for the static loading combination

-----  
Calculation of  $\mu_{u1+}$   
-----

-----  
Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:  
 $\phi_u = 5.6088283E-005$   
 $\mu_u = 4.3734E+008$   
-----

with full section properties:  
 $b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$

$$f_c = 33.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } c_u^* = \text{shear\_factor} * \text{Max}(c_u, c_c) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00650345$$

$$w_e \text{ (5.4c)} = 0.00563796$$

$$\text{ase ((5.4d), TBDY)} = (\text{ase1} * \text{Aext} + \text{ase2} * \text{Aint}) / \text{Asec} = 0.14776895$$

$$\text{ase1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

$$\text{ase2} = \text{Max}(\text{ase1}, \text{ase2}) = 0.14776895$$

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

$$\text{psh}_{\text{min}} * \text{Fywe} = \text{Min}(\text{psh}_{\text{x}} * \text{Fywe}, \text{psh}_{\text{y}} * \text{Fywe}) = 1.25908$$

$$\text{psh}_{\text{x}} * \text{Fywe} = \text{psh1} * \text{Fywe1} + \text{ps2} * \text{Fywe2} = 2.25223$$

$$\text{ps1 (external)} = (\text{Ash1} * h_1 / s_1) / \text{Asec} = 0.00261799$$

$$\text{Ash1} = \text{Astir}_{1} * \text{ns}_{1} = 157.0796$$

$$\text{No stirups, ns}_{1} = 2.00$$

$$h_1 = 670.00$$

$$\text{ps2 (internal)} = (\text{Ash2} * h_2 / s_2) / \text{Asec} = 0.00062519$$

$$\text{Ash2} = \text{Astir}_{2} * \text{ns}_{2} = 100.531$$

$$\text{No stirups, ns}_{2} = 2.00$$

$$h_2 = 500.00$$

$$\text{psh}_{\text{y}} * \text{Fywe} = \text{psh1} * \text{Fywe1} + \text{ps2} * \text{Fywe2} = 1.25908$$

$$\text{ps1 (external)} = (\text{Ash1} * h_1 / s_1) / \text{Asec} = 0.00156298$$

$$\text{Ash1} = \text{Astir}_{1} * \text{ns}_{1} = 157.0796$$

$$\text{No stirups, ns}_{1} = 2.00$$

$$h_1 = 400.00$$

$$\text{ps2 (internal)} = (\text{Ash2} * h_2 / s_2) / \text{Asec} = 0.00025008$$

$$\text{Ash2} = \text{Astir}_{2} * \text{ns}_{2} = 100.531$$

$$\text{No stirups, ns}_{2} = 2.00$$

$$h_2 = 200.00$$

$$\text{Asec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

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

$$l_o / l_{o,\text{min}} = l_b / l_d = 1.00$$

$$su_1 = 0.4 * esu_{1,\text{nominal}} \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu_{1,\text{nominal}} = 0.08,$$

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.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b / l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_1 = (f_{s,\text{jacket}} * A_{s,\text{ten,jacket}} + f_{s,\text{core}} * A_{s,\text{ten,core}}) / A_{s,\text{ten}} = 694.45$$

$$\text{with } Es_1 = (E_{s,\text{jacket}} * A_{s,\text{ten,jacket}} + E_{s,\text{core}} * A_{s,\text{ten,core}}) / A_{s,\text{ten}} = 200000.00$$

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 833.34$$

$$fy_2 = 694.45$$

$$su_2 = 0.032$$

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 = 694.45

with Es2 = (Es,jacket\*Asl,com,jacket + Es,core\*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 833.34

fyv = 694.45

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 = 694.45

with Esv = (Es,jacket\*Asl,mid,jacket + Es,mid\*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.05957415

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.10623177

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.03374111

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07073

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.0736092

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.13125889

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.04169017

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

v < vs,y2 - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.09006517

Mu = MRc (4.14) = 4.3734E+008

u = su (4.1) = 5.6088283E-005

-----  
Calculation of ratio lb/ld

-----  
Adequate Lap Length: lb/ld >= 1

-----  
Calculation of Mu1-

-----  
Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 5.9367084E-005

Mu = 7.4472E+008

-----  
with full section properties:

b = 400.00

d = 627.00

$d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $co (5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = shear\_factor * Max(cu, cc) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00650345$   
 $w_e (5.4c) = 0.00563796$   
 $ase ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo_1 = 340.00$   
 $ho_1 = 610.00$   
 $bi2_1 = 975400.00$   
 $ase2 = Max(ase1, ase2) = 0.14776895$   
 $bo_2 = 192.00$   
 $ho_2 = 492.00$   
 $bi2_2 = 557856.00$   
 $psh, min * F_{ywe} = Min(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.25908$

$psh, x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25223$   
 $ps1 (external) = (Ash1 * h1 / s1) / A_{sec} = 0.00261799$   
 $Ash1 = Astir_1 * ns_1 = 157.0796$   
 No stirups,  $ns_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 (internal) = (Ash2 * h2 / s2) / A_{sec} = 0.00062519$   
 $Ash2 = Astir_2 * ns_2 = 100.531$   
 No stirups,  $ns_2 = 2.00$   
 $h2 = 500.00$

$psh, y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25908$   
 $ps1 (external) = (Ash1 * h1 / s1) / A_{sec} = 0.00156298$   
 $Ash1 = Astir_1 * ns_1 = 157.0796$   
 No stirups,  $ns_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 (internal) = (Ash2 * h2 / s2) / A_{sec} = 0.00025008$   
 $Ash2 = Astir_2 * ns_2 = 100.531$   
 No stirups,  $ns_2 = 2.00$   
 $h2 = 200.00$

$A_{sec} = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $f_{ywe1} = 694.45$   
 $f_{ywe2} = 694.45$   
 $f_c = 33.00$

From ((5.A5), TBDY), TBDY:  $cc = 0.00232446$   
 $c = confinement\ factor = 1.03245$

$y1 = 0.0025$   
 $sh1 = 0.008$   
 $ft1 = 833.34$   
 $fy1 = 694.45$   
 $su1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $Shear\_factor = 1.00$

$lo/lo_{u,min} = lb/ld = 1.00$

$su1 = 0.4 * esu1\_nominal ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,

For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered  
 characteristic value  $fsy1 = fs1 / 1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs1 = (f_{s,jacket} * A_{sl,ten,jacket} + f_{s,core} * A_{sl,ten,core}) / A_{sl,ten} = 694.45$

with  $Es1 = (E_{s,jacket} * A_{sl,ten,jacket} + E_{s,core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$

$y2 = 0.0025$   
 $sh2 = 0.008$   
 $ft2 = 833.34$

$$f_y2 = 694.45$$

$$s_u2 = 0.032$$

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

$$l_o/l_{o,min} = l_b/l_{b,min} = 1.00$$

$$s_u2 = 0.4 * e_{s_u2,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY:  $e_{s_u2,nominal} = 0.08$ ,

For calculation of  $e_{s_u2,nominal}$  and  $y_2$ ,  $sh_2, ft_2, f_y2$ , it is considered  
characteristic value  $f_{s_y2} = f_{s_2}/1.2$ , 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.

$$\text{with } f_{s_2} = (f_{s,jacket} * A_{s_l,com,jacket} + f_{s,core} * A_{s_l,com,core}) / A_{s_l,com} = 694.45$$

$$\text{with } E_{s_2} = (E_{s,jacket} * A_{s_l,com,jacket} + E_{s,core} * A_{s_l,com,core}) / A_{s_l,com} = 200000.00$$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$f_{t_v} = 833.34$$

$$f_{y_v} = 694.45$$

$$s_{u_v} = 0.032$$

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

$$l_o/l_{o,min} = l_b/l_d = 1.00$$

$$s_{u_v} = 0.4 * e_{s_{u_v},nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY:  $e_{s_{u_v},nominal} = 0.08$ ,

considering characteristic value  $f_{s_{y_v}} = f_{s_v}/1.2$ , from table 5.1, TBDY

For calculation of  $e_{s_{u_v},nominal}$  and  $y_v$ ,  $sh_v, f_{t_v}, f_{y_v}$ , it is considered  
characteristic value  $f_{s_{y_v}} = f_{s_v}/1.2$ , from table 5.1, TBDY.

$y_1$ ,  $sh_1, ft_1, f_y1$ , are also multiplied by  $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.

$$\text{with } f_{s_v} = (f_{s,jacket} * A_{s_l,mid,jacket} + f_{s,mid} * A_{s_l,mid,core}) / A_{s_l,mid} = 694.45$$

$$\text{with } E_{s_v} = (E_{s,jacket} * A_{s_l,mid,jacket} + E_{s,mid} * A_{s_l,mid,core}) / A_{s_l,mid} = 200000.00$$

$$1 = A_{s_l,ten} / (b * d) * (f_{s_1} / f_c) = 0.10623177$$

$$2 = A_{s_l,com} / (b * d) * (f_{s_2} / f_c) = 0.05957415$$

$$v = A_{s_l,mid} / (b * d) * (f_{s_v} / f_c) = 0.03374111$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 34.07073$$

$$c_c (5A.5, TBDY) = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = A_{s_l,ten} / (b * d) * (f_{s_1} / f_c) = 0.13125889$$

$$2 = A_{s_l,com} / (b * d) * (f_{s_2} / f_c) = 0.0736092$$

$$v = A_{s_l,mid} / (b * d) * (f_{s_v} / f_c) = 0.04169017$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y_2}$  - LHS eq.(4.5) is not satisfied

--->

$v < v_{s,c}$  - RHS eq.(4.5) is satisfied

--->

$$s_u (4.8) = 0.1403202$$

$$M_u = M_{Rc} (4.15) = 7.4472E+008$$

$$u = s_u (4.1) = 5.9367084E-005$$

-----  
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:

$$u = 5.6088283E-005$$

Mu = 4.3734E+008

with full section properties:

b = 400.00

d = 627.00

d' = 43.00

v = 0.00027032

N = 2237.255

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu:  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00650345$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $cu = 0.00650345$

we (5.4c) = 0.00563796

ase ((5.4d), TBDY) =  $(ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$

ase1 = 0.14776895

bo\_1 = 340.00

ho\_1 = 610.00

bi2\_1 = 975400.00

ase2 =  $\text{Max}(ase1, ase2) = 0.14776895$

bo\_2 = 192.00

ho\_2 = 492.00

bi2\_2 = 557856.00

$psh, \min * F_{ywe} = \text{Min}(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.25908$

$psh, x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25223$

ps1 (external) =  $(Ash1 * h1 / s1) / A_{sec} = 0.00261799$

Ash1 =  $A_{stir,1} * ns_1 = 157.0796$

No stirups,  $ns_1 = 2.00$

h1 = 670.00

ps2 (internal) =  $(Ash2 * h2 / s2) / A_{sec} = 0.00062519$

Ash2 =  $A_{stir,2} * ns_2 = 100.531$

No stirups,  $ns_2 = 2.00$

h2 = 500.00

$psh, y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25908$

ps1 (external) =  $(Ash1 * h1 / s1) / A_{sec} = 0.00156298$

Ash1 =  $A_{stir,1} * ns_1 = 157.0796$

No stirups,  $ns_1 = 2.00$

h1 = 400.00

ps2 (internal) =  $(Ash2 * h2 / s2) / A_{sec} = 0.00025008$

Ash2 =  $A_{stir,2} * ns_2 = 100.531$

No stirups,  $ns_2 = 2.00$

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A.5), TBDY), TBDY:  $cc = 0.00232446$

c = confinement factor = 1.03245

y1 = 0.0025

sh1 = 0.008

ft1 = 833.34

fy1 = 694.45

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  $f_{s1} = (f_{s,jacket} \cdot A_{s,ten,jacket} + f_{s,core} \cdot A_{s,ten,core}) / A_{s,ten} = 694.45$   
 with  $E_{s1} = (E_{s,jacket} \cdot A_{s,ten,jacket} + E_{s,core} \cdot A_{s,ten,core}) / A_{s,ten} = 200000.00$   
 $y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$   
 $fy_2 = 694.45$   
 $su_2 = 0.032$   
 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  
 $l_0/l_{ou,min} = l_b/l_{b,min} = 1.00$   
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$   
 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  $f_{s2} = (f_{s,jacket} \cdot A_{s,com,jacket} + f_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 694.45$   
 with  $E_{s2} = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 200000.00$   
 $y_v = 0.0025$   
 $sh_v = 0.008$   
 $ft_v = 833.34$   
 $fy_v = 694.45$   
 $su_v = 0.032$   
 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  
 $l_0/l_{ou,min} = l_b/l_d = 1.00$   
 $su_v = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$   
 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  $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 694.45$   
 with  $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.05957415$   
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.10623177$   
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.03374111$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.0736092$   
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.13125889$   
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.04169017$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.09006517$   
 $Mu = MRc (4.14) = 4.3734E+008$   
 $u = su (4.1) = 5.6088283E-005$

-----  
 Calculation of ratio  $l_b/l_d$   
 -----

Adequate Lap Length:  $l_b/l_d \geq 1$   
 -----  
 -----  
 -----

Calculation of  $Mu_2$ -  
 -----

Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

$$u = 5.9367084E-005$$

$$Mu = 7.4472E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o(5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00650345$$

$$w_e(5.4c) = 0.00563796$$

$$a_{se}((5.4d), \text{TBDY}) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$$

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25223$$

$$p_{s1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25908$$

$$p_{s1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A.5), TBDY), TBDY: } \phi_{cc} = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

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

$$l_o / l_{ou, \min} = l_b / d = 1.00$$

$$su_1 = 0.4 * e_{su1\_nominal}((5.5), \text{TBDY}) = 0.032$$

From table 5A.1, TBDY:  $e_{su1\_nominal} = 0.08$ ,

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  $fs1 = (fs_{jacket} \cdot Asl_{ten,jacket} + fs_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 694.45$

with  $Es1 = (Es_{jacket} \cdot Asl_{ten,jacket} + Es_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 200000.00$

$y2 = 0.0025$

$sh2 = 0.008$

$ft2 = 833.34$

$fy2 = 694.45$

$su2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with  $shear\_factor$  and also multiplied by the  $shear\_factor$  according to 15.7.1.4, with  $Shear\_factor = 1.00$

$lo/lo_{ou,min} = lb/lb_{,min} = 1.00$

$su2 = 0.4 \cdot esu2\_nominal ((5.5), TBDY) = 0.032$

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  $fs2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 694.45$

with  $Es2 = (Es_{jacket} \cdot Asl_{com,jacket} + Es_{core} \cdot Asl_{com,core}) / Asl_{com} = 200000.00$

$yv = 0.0025$

$shv = 0.008$

$ftv = 833.34$

$fyv = 694.45$

$suv = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with  $shear\_factor$  and also multiplied by the  $shear\_factor$  according to 15.7.1.4, with  $Shear\_factor = 1.00$

$lo/lo_{ou,min} = lb/ld = 1.00$

$suv = 0.4 \cdot esuv\_nominal ((5.5), TBDY) = 0.032$

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  $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 694.45$

with  $Es_v = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$

$1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.10623177$

$2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.05957415$

$v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.03374111$

and confined core properties:

$b = 340.00$

$d = 597.00$

$d' = 13.00$

$f_{cc} (5A.2, TBDY) = 34.07073$

$cc (5A.5, TBDY) = 0.00232446$

$c = \text{confinement factor} = 1.03245$

$1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.13125889$

$2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.0736092$

$v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.04169017$

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

--->

$su (4.8) = 0.1403202$

$Mu = MRc (4.15) = 7.4472E+008$

$u = su (4.1) = 5.9367084E-005$

Calculation of ratio  $lb/ld$

Adequate Lap Length:  $lb/ld \geq 1$

-----  
-----  
Calculation of Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 558200.119$

-----  
Calculation of Shear Strength at edge 1,  $V_{r1} = 558200.119$   
 $V_{r1} = V_n$  ((22.5.1.1), ACI 318-14)

-----  
NOTE: In expression (22.5.1.1) ' $V_w$ ' is replaced by ' $V_w + f \cdot V_f$ '  
where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

-----  
From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot \text{Area}_{jacket} + f'_{c\_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$ , but  $f_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)  
 $p_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / \mu < 1 = 1.00$   
 $\mu = 1.0197E+006$   
 $V_u = 9840.633$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 349068.643$   
 $V_{s1} = 311834.654$  is calculated for jacket, with:  
 $d = 536.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 37233.989$  is calculated for jacket, with:  
 $d_2 = 400.00$   
 $A_v = 100530.965$   
 $f_y = 555.56$   
 $s = 300.00$   
 $V_{s2}$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)  
 $2(1-s/d) = 0.50$   
 $V_f$  ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

-----  
Calculation of Shear Strength at edge 2,  $V_{r2} = 558200.119$   
 $V_{r2} = V_n$  ((22.5.1.1), ACI 318-14)

-----  
NOTE: In expression (22.5.1.1) ' $V_w$ ' is replaced by ' $V_w + f \cdot V_f$ '  
where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

-----  
From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot \text{Area}_{jacket} + f'_{c\_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$ , but  $f_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)  
 $p_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / \mu < 1 = 1.00$   
 $\mu = 1.0197E+006$   
 $V_u = 9840.633$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 349068.643$   
 $V_{s1} = 311834.654$  is calculated for jacket, with:  
 $d = 536.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 37233.989$  is calculated for jacket, with:  
 $d = 400.00$   
 $A_v = 100530.965$   
 $f_y = 555.56$

s = 300.00

Vs2 has been multiplied by 2(1-s/d) (s>d/2, according to ASCE 41-17,10.3.4)

2(1-s/d) = 0.50

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: Vs + Vf <= 818179.336

-----  
End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 3

-----  
Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

-----  
Knowledge Factor, = 1.00

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Primary Member: Concrete Strength, fc = fcm = 33.00

New material of Primary Member: Steel Strength, fs = fsm = 555.56

Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00

Existing Column

New material of Primary Member: Concrete Strength, fc = fcm = 33.00

New material of Primary Member: Steel Strength, fs = fsm = 555.56

Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, fs = 1.25\*fsm = 694.45

Existing Column

New material: Steel Strength, fs = 1.25\*fsm = 694.45

#####

External Height, H = 670.00

External Width, W = 400.00

Internal Height, H = 500.00

Internal Width, W = 200.00

Cover Thickness, c = 25.00

Mean Confinement Factor overall section = 1.03245

Element Length, L = 3000.00

Primary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length (lo/lou,min>= 1)

No FRP Wrapping

-----  
Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, Va = -6.9721474E-015

EDGE -B-

Shear Force, Vb = 6.9721474E-015

BOTH EDGES

Axial Force, F = -2237.255

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: Aslt = 709.9999

-Compression:  $Asl,c = 1668.186$   
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $Asl,t = 911.0619$   
-Compression:  $Asl,c = 911.0619$   
-Middle:  $Asl,m = 556.0619$

Calculation of Shear Capacity ratio,  $V_e/V_r = 0.53480887$

Member Controlled by Flexure ( $V_e/V_r < 1$ )

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 204955.561$   
with

$M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 3.0743E+008$

$Mu_{1+} = 3.0743E+008$ , 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

$Mu_{1-} = 3.0743E+008$ , 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

$M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 3.0743E+008$

$Mu_{2+} = 3.0743E+008$ , 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

$Mu_{2-} = 3.0743E+008$ , 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

$V_1 = -6.9721474E-015$ , is the shear force acting at edge 1 for the the static loading combination

$V_2 = 6.9721474E-015$ , is the shear force acting at edge 2 for the the static loading combination

Calculation of  $Mu_{1+}$

Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

$\phi_u = 0.00010406$

$M_u = 3.0743E+008$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$f_c = 33.00$

$\phi_c$  (5A.5, TBDY) = 0.002

Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00650345$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $\phi_u = 0.00650345$

$w_e$  (5.4c) = 0.00563796

$a_{se}$  ((5.4d), TBDY) =  $(a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int})/A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o1} = 340.00$

$h_{o1} = 610.00$

$b_{i21} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o2} = 192.00$

$h_{o2} = 492.00$

$b_{i22} = 557856.00$

$p_{sh, \min} \cdot F_{ywe} = \text{Min}(p_{sh,x} \cdot F_{ywe}, p_{sh,y} \cdot F_{ywe}) = 1.25908$

$p_{sh,x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{sh2} \cdot F_{ywe2} = 2.25223$

$p_{s1}$  (external) =  $(A_{sh1} \cdot h_1/s_1)/A_{sec} = 0.00261799$

$A_{sh1} = A_{stir,1} \cdot n_{s,1} = 157.0796$

No stirups,  $n_{s,1} = 2.00$

$h_1 = 670.00$

$p_{s2}$  (internal) =  $(A_{sh2} \cdot h_2/s_2)/A_{sec} = 0.00062519$

Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00156298  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 400.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00025008  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00232446

c = confinement factor = 1.03245

y1 = 0.0025

sh1 = 0.008

ft1 = 833.34

fy1 = 694.45

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 = 694.45

with Es1 = (Es,jacket\*Asl,ten,jacket + Es,core\*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025

sh2 = 0.008

ft2 = 833.34

fy2 = 694.45

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 = 694.45

with Es2 = (Es,jacket\*Asl,com,jacket + Es,core\*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 833.34

fyv = 694.45

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  $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 694.45$

with  $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.08015524$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.08015524$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.04892233$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

$f_{cc} (5A.2, TBDY) = 34.07073$

$cc (5A.5, TBDY) = 0.00232446$

$c = \text{confinement factor} = 1.03245$

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.09611636$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.09611636$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.05866412$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

$v < v_{s,c}$  - RHS eq.(4.5) is satisfied

---->

$su (4.9) = 0.13857861$

$Mu = MRc (4.14) = 3.0743E+008$

$u = su (4.1) = 0.00010406$

-----  
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:

$u = 0.00010406$

$Mu = 3.0743E+008$   
-----

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$f_c = 33.00$

$co (5A.5, TBDY) = 0.002$

Final value of  $cu$ :  $cu^* = \text{shear\_factor} \cdot \text{Max}(cu, cc) = 0.00650345$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $cu = 0.00650345$

$w_e (5.4c) = 0.00563796$

$ase ((5.4d), TBDY) = (ase_1 \cdot A_{ext} + ase_2 \cdot A_{int}) / A_{sec} = 0.14776895$

$ase_1 = 0.14776895$

$bo_1 = 340.00$

$ho_1 = 610.00$

$bi_2_1 = 975400.00$

$ase_2 = \text{Max}(ase_1, ase_2) = 0.14776895$

$bo_2 = 192.00$

$ho_2 = 492.00$

$bi_2_2 = 557856.00$

$psh, \text{min} \cdot F_{ywe} = \text{Min}(psh, x \cdot F_{ywe}, psh, y \cdot F_{ywe}) = 1.25908$   
-----

$psh, x \cdot F_{ywe} = psh_1 \cdot F_{ywe1} + ps_2 \cdot F_{ywe2} = 2.25223$

$ps_1 (\text{external}) = (A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$

No stirups, ns<sub>1</sub> = 2.00  
h<sub>1</sub> = 670.00  
ps<sub>2</sub> (internal) = (Ash<sub>2</sub>\*h<sub>2</sub>/s<sub>2</sub>)/Asec = 0.00062519  
Ash<sub>2</sub> = Astir<sub>2</sub>\*ns<sub>2</sub> = 100.531  
No stirups, ns<sub>2</sub> = 2.00  
h<sub>2</sub> = 500.00

-----  
psh<sub>y</sub>\*Fywe = psh<sub>1</sub>\*Fywe<sub>1</sub>+ps<sub>2</sub>\*Fywe<sub>2</sub> = 1.25908  
ps<sub>1</sub> (external) = (Ash<sub>1</sub>\*h<sub>1</sub>/s<sub>1</sub>)/Asec = 0.00156298  
Ash<sub>1</sub> = Astir<sub>1</sub>\*ns<sub>1</sub> = 157.0796  
No stirups, ns<sub>1</sub> = 2.00  
h<sub>1</sub> = 400.00  
ps<sub>2</sub> (internal) = (Ash<sub>2</sub>\*h<sub>2</sub>/s<sub>2</sub>)/Asec = 0.00025008  
Ash<sub>2</sub> = Astir<sub>2</sub>\*ns<sub>2</sub> = 100.531  
No stirups, ns<sub>2</sub> = 2.00  
h<sub>2</sub> = 200.00

-----  
Asec = 268000.00  
s<sub>1</sub> = 150.00  
s<sub>2</sub> = 300.00  
fywe<sub>1</sub> = 694.45  
fywe<sub>2</sub> = 694.45  
fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.00232446  
c = confinement factor = 1.03245

y<sub>1</sub> = 0.0025  
sh<sub>1</sub> = 0.008  
ft<sub>1</sub> = 833.34  
fy<sub>1</sub> = 694.45  
su<sub>1</sub> = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with 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<sub>1</sub> = 0.4\*esu<sub>1</sub>\_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu<sub>1</sub>\_nominal = 0.08,

For calculation of esu<sub>1</sub>\_nominal and y<sub>1</sub>, sh<sub>1</sub>,ft<sub>1</sub>,fy<sub>1</sub>, it is considered  
characteristic value fsy<sub>1</sub> = fs<sub>1</sub>/1.2, from table 5.1, TBDY.

y<sub>1</sub>, sh<sub>1</sub>,ft<sub>1</sub>,fy<sub>1</sub>, are also multiplied by Min(1,1.25\*(lb/ld)<sup>2/3</sup>), from 10.3.5, ASCE 41-17.

with fs<sub>1</sub> = (fs,jacket\*Asl,ten,jacket + fs,core\*Asl,ten,core)/Asl,ten = 694.45

with Es<sub>1</sub> = (Es,jacket\*Asl,ten,jacket + Es,core\*Asl,ten,core)/Asl,ten = 200000.00

y<sub>2</sub> = 0.0025  
sh<sub>2</sub> = 0.008  
ft<sub>2</sub> = 833.34  
fy<sub>2</sub> = 694.45  
su<sub>2</sub> = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear\_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<sub>2</sub> = 0.4\*esu<sub>2</sub>\_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu<sub>2</sub>\_nominal = 0.08,

For calculation of esu<sub>2</sub>\_nominal and y<sub>2</sub>, sh<sub>2</sub>,ft<sub>2</sub>,fy<sub>2</sub>, it is considered  
characteristic value fsy<sub>2</sub> = fs<sub>2</sub>/1.2, from table 5.1, TBDY.

y<sub>2</sub>, sh<sub>2</sub>,ft<sub>2</sub>,fy<sub>2</sub>, are also multiplied by Min(1,1.25\*(lb/ld)<sup>2/3</sup>), from 10.3.5, ASCE 41-17.

with fs<sub>2</sub> = (fs,jacket\*Asl,com,jacket + fs,core\*Asl,com,core)/Asl,com = 694.45

with Es<sub>2</sub> = (Es,jacket\*Asl,com,jacket + Es,core\*Asl,com,core)/Asl,com = 200000.00

y<sub>v</sub> = 0.0025  
sh<sub>v</sub> = 0.008  
ft<sub>v</sub> = 833.34  
fy<sub>v</sub> = 694.45  
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  $fsv = fsv/1.2$ , 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.  
 $y1, sh1,ft1,fy1$ , are also multiplied by  $Min(1,1.25*(lb/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs_{jacket}*Asl_{mid,jacket} + fs_{mid}*Asl_{mid,core})/Asl_{mid} = 694.45$   
 with  $Esv = (Es_{jacket}*Asl_{mid,jacket} + Es_{mid}*Asl_{mid,core})/Asl_{mid} = 200000.00$   
 $1 = Asl_{ten}/(b*d)*(fs1/fc) = 0.08015524$   
 $2 = Asl_{com}/(b*d)*(fs2/fc) = 0.08015524$   
 $v = Asl_{mid}/(b*d)*(fsv/fc) = 0.04892233$

and confined core properties:

$b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc$  (5A.2, TBDY) = 34.07073  
 $cc$  (5A.5, TBDY) = 0.00232446  
 $c =$  confinement factor = 1.03245  
 $1 = Asl_{ten}/(b*d)*(fs1/fc) = 0.09611636$   
 $2 = Asl_{com}/(b*d)*(fs2/fc) = 0.09611636$   
 $v = Asl_{mid}/(b*d)*(fsv/fc) = 0.05866412$

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) = 0.13857861  
 $Mu = MRc$  (4.14) = 3.0743E+008  
 $u = su$  (4.1) = 0.00010406

-----  
 Calculation of ratio  $lb/l_d$

-----  
 Adequate Lap Length:  $lb/l_d \geq 1$

-----  
 Calculation of  $Mu_{2+}$

-----  
 Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:

$u = 0.00010406$   
 $Mu = 3.0743E+008$

-----  
 with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $fc = 33.00$   
 $co$  (5A.5, TBDY) = 0.002  
 Final value of  $cu$ :  $cu^* = shear\_factor * Max(cu, cc) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00650345$   
 $w_e$  (5.4c) = 0.00563796  
 $ase$  ((5.4d), TBDY) =  $(ase1*A_{ext} + ase2*A_{int})/A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo\_1 = 340.00$   
 $ho\_1 = 610.00$   
 $bi2\_1 = 975400.00$   
 $ase2 = Max(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$   
 $psh_{min}*Fy_{we} = Min(psh_x*Fy_{we}, psh_y*Fy_{we}) = 1.25908$

psh\_x\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 2.25223  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00261799  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 670.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00062519  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00156298  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 400.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00025008  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00232446

c = confinement factor = 1.03245

y1 = 0.0025

sh1 = 0.008

ft1 = 833.34

fy1 = 694.45

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 = 694.45

with Es1 = (Es,jacket\*Asl,ten,jacket + Es,core\*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025

sh2 = 0.008

ft2 = 833.34

fy2 = 694.45

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 = 694.45

with Es2 = (Es,jacket\*Asl,com,jacket + Es,core\*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 833.34

fyv = 694.45

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

su = 0.4\*esuv\_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv\_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv\_nominal and yv, shv,ftv,fyv, it is considered characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25\*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.

with fsv = (fsjacket\*Asl,mid,jacket + fs,mid\*Asl,mid,core)/Asl,mid = 694.45

with Esv = (Es,jacket\*Asl,mid,jacket + Es,mid\*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.08015524

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.08015524

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.04892233

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07073

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.09611636

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.09611636

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.05866412

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) = 0.13857861

Mu = MRc (4.14) = 3.0743E+008

u = su (4.1) = 0.00010406

-----  
Calculation of ratio lb/d

-----  
Adequate Lap Length: lb/d >= 1

-----  
Calculation of Mu2-

-----  
Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 0.00010406

Mu = 3.0743E+008

-----  
with full section properties:

b = 670.00

d = 357.00

d' = 43.00

v = 0.00028344

N = 2237.255

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu: cu\* = shear\_factor \* Max( cu, cc) = 0.00650345

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.00650345

we (5.4c) = 0.00563796

ase ((5.4d), TBDY) = (ase1\*Aext+ase2\*Aint)/Asec = 0.14776895

ase1 = 0.14776895

bo\_1 = 340.00

ho\_1 = 610.00

bi2\_1 = 975400.00

ase2 = Max(ase1,ase2) = 0.14776895

bo\_2 = 192.00

ho\_2 = 492.00

$$bi2\_2 = 557856.00$$
$$psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.25908$$

$$psh\_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.25223$$
$$ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00261799$$
$$Ash1 = Astir\_1*ns\_1 = 157.0796$$
$$\text{No stirups, } ns\_1 = 2.00$$
$$h1 = 670.00$$
$$ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00062519$$
$$Ash2 = Astir\_2*ns\_2 = 100.531$$
$$\text{No stirups, } ns\_2 = 2.00$$
$$h2 = 500.00$$

$$psh\_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.25908$$
$$ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00156298$$
$$Ash1 = Astir\_1*ns\_1 = 157.0796$$
$$\text{No stirups, } ns\_1 = 2.00$$
$$h1 = 400.00$$
$$ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00025008$$
$$Ash2 = Astir\_2*ns\_2 = 100.531$$
$$\text{No stirups, } ns\_2 = 2.00$$
$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 694.45$$

$$fce = 33.00$$

$$\text{From } ((5.A.5), \text{ TBDY}), \text{ TBDY: } cc = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 833.34$$

$$fy1 = 694.45$$

$$su1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor and also multiplied by the shear\_factor according to 15.7.1.4, with Shear\_factor = 1.00

$$lo/lou,min = lb/l_d = 1.00$$

$$su1 = 0.4*esu1\_nominal \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu1\_nominal = 0.08,$$

For calculation of esu1\_nominal and y1, sh1, ft1, fy1, it is considered characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25*(lb/l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45$$

$$\text{with } Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 833.34$$

$$fy2 = 694.45$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor and also multiplied by the shear\_factor according to 15.7.1.4, with Shear\_factor = 1.00

$$lo/lou,min = lb/l_b,min = 1.00$$

$$su2 = 0.4*esu2\_nominal \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu2\_nominal = 0.08,$$

For calculation of esu2\_nominal and y2, sh2, ft2, fy2, it is considered characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25*(lb/l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45$$

$$\text{with } Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 833.34$$

$$fyv = 694.45$$

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 = (fsjacket\*Asl,mid,jacket + fs,mid\*Asl,mid,core)/Asl,mid = 694.45

with Esv = (Es,jacket\*Asl,mid,jacket + Es,mid\*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.08015524

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.08015524

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.04892233

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07073

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.09611636

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.09611636

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.05866412

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) = 0.13857861

Mu = MRc (4.14) = 3.0743E+008

u = su (4.1) = 0.00010406

-----  
Calculation of ratio lb/d

-----  
Adequate Lap Length: lb/d >= 1  
-----  
-----  
-----

-----  
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 383231.42  
-----

-----  
Calculation of Shear Strength at edge 1, Vr1 = 383231.42

Vr1 = Vn ((22.5.1.1), ACI 318-14)

-----  
NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f\*Vf'  
where Vf is the contribution of FRPs (11.3), ACI 440).  
-----

From Table (22.5.5.1), ACI 318-14: Vc = 197061.477

= 1 (normal-weight concrete)

Mean concrete strength: fc' = (fc'\_jacket\*Area\_jacket + fc'\_core\*Area\_core)/Area\_section = 33.00, but  $fc'^{0.5} \leq 8.3$   
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 = 8.6547052E-012

Vu = 6.9721474E-015

From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 186169.943

Vs1 = 186169.943 is calculated for jacket, with:

d = 320.00

Av = 157079.633

fy = 555.56

s = 150.00

Vs1 has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

Vs2 = 0.00 is calculated for jacket, with:

d2 = 160.00

Av = 100530.965

fy = 555.56

s = 300.00

Vs2 is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

-----  
Calculation of Shear Strength at edge 2, Vr2 = 383231.42

Vr2 = Vn ((22.5.1.1), ACI 318-14)

-----  
NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f\*Vf'  
where Vf is the contribution of FRPs (11.3), ACI 440).

-----  
From Table (22.5.5.1), ACI 318-14: Vc = 197061.477

= 1 (normal-weight concrete)

Mean concrete strength:  $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 33.00$ , but  $f_c'^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)

pw = As/(bw\*d) = 0.00331157

As (tension reinf.) = 709.9999

bw = 670.00

d = 320.00

Vu\*d/Mu < 1 = 0.00

Mu = 1.2266780E-011

Vu = 6.9721474E-015

From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 186169.943

Vs1 = 186169.943 is calculated for jacket, with:

d = 320.00

Av = 157079.633

fy = 555.56

s = 150.00

Vs1 has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

Vs2 = 0.00 is calculated for jacket, with:

d = 160.00

Av = 100530.965

fy = 555.56

s = 300.00

Vs2 is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

-----  
End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

-----  
Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcjars

Constant Properties

-----  
Knowledge Factor, = 1.00

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$   
New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$   
Concrete Elasticity,  $E_c = 26999.444$   
Steel Elasticity,  $E_s = 200000.00$   
External Height,  $H = 670.00$   
External Width,  $W = 400.00$   
Internal Height,  $H = 500.00$   
Internal Width,  $W = 200.00$   
Cover Thickness,  $c = 25.00$   
Element Length,  $L = 3000.00$   
Primary Member  
Smooth Bars  
Ductile Steel  
With Detailing for Earthquake Resistance (including stirrups closed at  $135^\circ$ )  
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,  $M = -1.0550018E-010$   
Shear Force,  $V_2 = -5.6924552E-014$   
Shear Force,  $V_3 = 4020.289$   
Axial Force,  $F = -3615.233$   
Longitudinal Reinforcement Area Distribution (in 2 divisions)  
-Tension:  $A_{st} = 709.9999$   
-Compression:  $A_{sc} = 1668.186$   
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $A_{st,ten} = 911.0619$   
-Compression:  $A_{st,com} = 911.0619$   
-Middle:  $A_{st,mid} = 556.0619$   
Longitudinal External Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $A_{st,ten,jacket} = 603.1858$   
-Compression:  $A_{st,com,jacket} = 603.1858$   
-Middle:  $A_{st,mid,jacket} = 402.1239$   
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $A_{st,ten,core} = 307.8761$   
-Compression:  $A_{st,com,core} = 307.8761$   
-Middle:  $A_{st,mid,core} = 153.938$   
Mean Diameter of Tension Reinforcement,  $DbL = 15.20$

-----  
New component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u_{,R} = 1.0^*$   $u = 0.03344037$   
 $u = y + p = 0.03344037$

-----  
- Calculation of  $y$  -

-----  
 $y = (M_y * L_s / 3) / E_{eff} = 0.00344037$  ((4.29), Biskinis Phd))  
 $M_y = 1.9915E+008$   
 $L_s = M/V$  (with  $L_s > 0.1 * L$  and  $L_s < 2 * L$ ) =  $1500.00$   
From table 10.5, ASCE 41\_17:  $E_{eff} = 0.3 * E_c * I_g = 2.8943E+013$

-----  
Calculation of Yielding Moment  $M_y$

-----  
Calculation of  $y$  and  $M_y$  according to Annex 7 -

-----  
 $y = \text{Min}(y_{ten}, y_{com})$   
 $y_{ten} = 1.0019693E-005$   
with  $f_y = 555.56$   
 $d = 357.00$   
 $y = 0.22343403$

A = 0.00996987  
 B = 0.00559733  
 with pt = 0.00380895  
   pc = 0.00380895  
   pv = 0.00232477  
   N = 3615.233  
   b = 670.00  
   " = 0.12044818  
 y\_comp = 2.7622785E-005  
 with fc = 33.00  
   Ec = 26999.444  
   y = 0.22309813  
   A = 0.00990831  
   B = 0.00557012  
   with Es = 200000.00

-----  
 Calculation of ratio lb/d

-----  
 Adequate Lap Length: lb/d >= 1

-----  
 - Calculation of p -

-----  
 From table 10-7: p = 0.03

with:

- Condition i occurred

Beam controlled by flexure:  $V_p/V_o \leq 1$

shear control ratio  $V_p/V_o = 0.53480887$

- Transverse Reinforcement: NC

- Stirrup Spacing > d/3

- Low ductility demand,  $\lambda < 2$  (table 10-6, ASCE 41-17)

= 9.9381411E-023

- Stirrup Spacing <= d/2

d = d\_external = 357.00

s = s\_external = 150.00

- Strength provided by hoops  $V_s < 3/4$ \*design Shear

$V_s = 215957.134$ , already given in calculation of shear control ratio

design Shear = 5.6924552E-014

- ( - ')/ bal = -0.23508921

=  $A_{st}/(b_w*d) = 0.00296835$

Tension Reinf Area:  $A_{st} = 709.9999$

' =  $A_{sc}/(b_w*d) = 0.00697431$

Compression Reinf Area:  $A_{sc} = 1668.186$

From (B-1), ACI 318-11: bal = 0.01704017

$f_c = (f_{c\_jacket}*Area\_jacket + f_{c\_core}*Area\_core)/section\_area = 33.00$

$f_y = f_{y\_jacket\_bars} = 555.56$

From 10.2.7.3, ACI 318-11:  $\lambda = 0.65$

From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + \lambda) = 0.51922877$

$\lambda = 0.0027778$

-  $V/(b_w*d*f_c^{0.5}) = 4.9891075E-019$ , 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

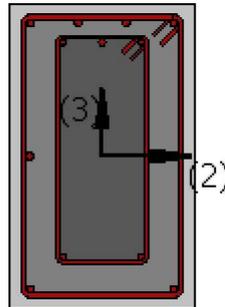
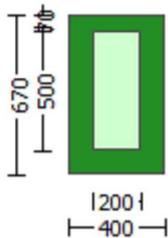
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity  $V_{Rd}$

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups 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,  $M_a = -1.0550018E-010$

Shear Force,  $V_a = -5.6924552E-014$

EDGE -B-

Bending Moment,  $M_b = -6.5336195E-011$

Shear Force,  $V_b = 5.6924552E-014$

BOTH EDGES

Axial Force,  $F = -3615.233$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $As_t = 709.9999$

-Compression:  $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{t,ten} = 911.0619$

-Compression:  $As_{c,com} = 911.0619$

-Middle:  $As_{mid} = 556.0619$

Mean Diameter of Tension Reinforcement,  $Db_{L,ten} = 15.20$

-----  
New component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $V_R = 1.0 \cdot V_n = 339071.608$   
 $V_n$  ((22.5.1.1), ACI 318-14) = 339071.608

-----  
NOTE: In expression (22.5.1.1) ' $V_w$ ' is replaced by ' $V_{w+ f \cdot V_f}$ '  
where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

-----  
From Table (22.5.5.1), ACI 318-14:  $V_c = 171520.00$

= 1 (normal-weight concrete)

Mean concrete strength:  $f'_c = (f'_{c,jacket} \cdot Area_{jacket} + f'_{c,core} \cdot Area_{core}) / Area_{section} = 25.00$ , but  $f'_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)

$\rho_w = A_s / (b_w \cdot d) = 0.00331157$

$A_s$  (tension reinf.) = 709.9999

$b_w = 670.00$

$d = 320.00$

$V_u \cdot d / M_u < 1 = 0.00$

$M_u = 6.5336195E-011$

$V_u = 5.6924552E-014$

From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 167551.608$

$V_{s1} = 167551.608$  is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 500.00$

$s = 150.00$

$V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

$V_{s2} = 0.00$  is calculated for core, with:

$d = 160.00$

$A_v = 100530.965$

$f_y = 500.00$

$s = 300.00$

$V_{s2}$  is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

$V_f$  ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440:  $V_s + V_f \leq 712133.705$

-----  
End Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

## Calculation No. 14

beam B1, Floor 1

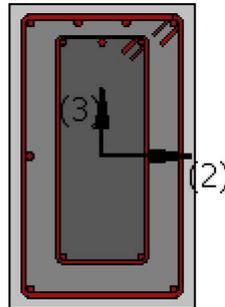
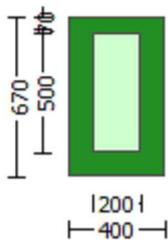
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (  $\theta$  )

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$

Existing Column

New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$   
Mean Confinement Factor overall section = 1.03245  
Element Length,  $L = 3000.00$   
Primary Member  
Smooth Bars  
Ductile Steel  
With Detailing for Earthquake Resistance (including stirrups closed at  $135^\circ$ )  
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,  $V_a = 9840.633$   
EDGE -B-  
Shear Force,  $V_b = 9840.633$   
BOTH EDGES  
Axial Force,  $F = -2237.255$   
Longitudinal Reinforcement Area Distribution (in 2 divisions)  
-Tension:  $A_{st} = 709.9999$   
-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,  $V_e/V_r = 0.90705729$   
Member Controlled by Flexure ( $V_e/V_r < 1$ )  
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 506319.489$   
with  
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 7.4472E+008$   
 $\mu_{u1+} = 4.3734E+008$ , 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  
 $\mu_{u1-} = 7.4472E+008$ , is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination  
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 7.4472E+008$   
 $\mu_{u2+} = 4.3734E+008$ , 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  
 $\mu_{u2-} = 7.4472E+008$ , is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination  
and  
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$   
with  
 $V_1 = 9840.633$ , is the shear force acting at edge 1 for the static loading combination  
 $V_2 = 9840.633$ , is the shear force acting at edge 2 for the static loading combination

-----  
Calculation of  $\mu_{u1+}$   
-----

-----  
Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:  
 $\phi_u = 5.6088283E-005$   
 $\mu_u = 4.3734E+008$   
-----

with full section properties:  
 $b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu:  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00650345$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $cu = 0.00650345$

we (5.4c) = 0.00563796

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

$psh_{min} * Fy_{we} = \text{Min}(psh_x * Fy_{we}, psh_y * Fy_{we}) = 1.25908$

$psh_x * Fy_{we} = psh1 * Fy_{we1} + ps2 * Fy_{we2} = 2.25223$

ps1 (external) =  $(Ash1 * h1 / s1) / A_{sec} = 0.00261799$

Ash1 =  $A_{stir\_1} * ns_1 = 157.0796$

No stirups,  $ns_1 = 2.00$

h1 = 670.00

ps2 (internal) =  $(Ash2 * h2 / s2) / A_{sec} = 0.00062519$

Ash2 =  $A_{stir\_2} * ns_2 = 100.531$

No stirups,  $ns_2 = 2.00$

h2 = 500.00

$psh_y * Fy_{we} = psh1 * Fy_{we1} + ps2 * Fy_{we2} = 1.25908$

ps1 (external) =  $(Ash1 * h1 / s1) / A_{sec} = 0.00156298$

Ash1 =  $A_{stir\_1} * ns_1 = 157.0796$

No stirups,  $ns_1 = 2.00$

h1 = 400.00

ps2 (internal) =  $(Ash2 * h2 / s2) / A_{sec} = 0.00025008$

Ash2 =  $A_{stir\_2} * ns_2 = 100.531$

No stirups,  $ns_2 = 2.00$

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A5), TBDY), TBDY:  $cc = 0.00232446$

c = confinement factor = 1.03245

y1 = 0.0025

sh1 = 0.008

ft1 = 833.34

fy1 = 694.45

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.

with  $fs1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 694.45$

with  $Es1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$

y2 = 0.0025

sh2 = 0.008

ft2 = 833.34

fy2 = 694.45

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 = 694.45

with Es2 = (Es,jacket\*Asl,com,jacket + Es,core\*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 833.34

fyv = 694.45

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 = 694.45

with Esv = (Es,jacket\*Asl,mid,jacket + Es,mid\*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.05957415

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.10623177

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.03374111

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07073

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.0736092

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.13125889

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.04169017

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

v < vs,y2 - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.09006517

Mu = MRc (4.14) = 4.3734E+008

u = su (4.1) = 5.6088283E-005

-----  
Calculation of ratio lb/ld

-----  
Adequate Lap Length: lb/ld >= 1

-----  
Calculation of Mu1-

-----  
Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 5.9367084E-005

Mu = 7.4472E+008

-----  
with full section properties:

b = 400.00

d = 627.00

$d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$   
 $fc = 33.00$   
 $co (5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = shear\_factor * Max(cu, cc) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00650345$   
 $we (5.4c) = 0.00563796$   
 $ase ((5.4d), TBDY) = (ase1 * Aext + ase2 * Aint) / Asec = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo_1 = 340.00$   
 $ho_1 = 610.00$   
 $bi2_1 = 975400.00$   
 $ase2 = Max(ase1, ase2) = 0.14776895$   
 $bo_2 = 192.00$   
 $ho_2 = 492.00$   
 $bi2_2 = 557856.00$   
 $psh, min * Fywe = Min(psh, x * Fywe, psh, y * Fywe) = 1.25908$

$psh, x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 2.25223$   
 $ps1 (external) = (Ash1 * h1 / s1) / Asec = 0.00261799$   
 $Ash1 = Astir_1 * ns_1 = 157.0796$   
 No stirups,  $ns_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 (internal) = (Ash2 * h2 / s2) / Asec = 0.00062519$   
 $Ash2 = Astir_2 * ns_2 = 100.531$   
 No stirups,  $ns_2 = 2.00$   
 $h2 = 500.00$

$psh, y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.25908$   
 $ps1 (external) = (Ash1 * h1 / s1) / Asec = 0.00156298$   
 $Ash1 = Astir_1 * ns_1 = 157.0796$   
 No stirups,  $ns_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 (internal) = (Ash2 * h2 / s2) / Asec = 0.00025008$   
 $Ash2 = Astir_2 * ns_2 = 100.531$   
 No stirups,  $ns_2 = 2.00$   
 $h2 = 200.00$

$Asec = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fywe1 = 694.45$   
 $fywe2 = 694.45$   
 $fce = 33.00$

From ((5.A5), TBDY), TBDY:  $cc = 0.00232446$   
 $c = confinement\ factor = 1.03245$

$y1 = 0.0025$   
 $sh1 = 0.008$   
 $ft1 = 833.34$   
 $fy1 = 694.45$   
 $su1 = 0.032$

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  $fs1 = (fs, jacket * Asl, ten, jacket + fs, core * Asl, ten, core) / Asl, ten = 694.45$

with  $Es1 = (Es, jacket * Asl, ten, jacket + Es, core * Asl, ten, core) / Asl, ten = 200000.00$

$y2 = 0.0025$   
 $sh2 = 0.008$   
 $ft2 = 833.34$

$$f_y2 = 694.45$$

$$s_u2 = 0.032$$

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

$$l_o/l_{o,u,min} = l_b/l_{b,min} = 1.00$$

$$s_u2 = 0.4 * e_{su2,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY:  $e_{su2,nominal} = 0.08$ ,

For calculation of  $e_{su2,nominal}$  and  $y_2$ ,  $sh_2$ ,  $ft_2$ ,  $f_y2$ , it is considered  
characteristic value  $f_{sy2} = f_{s2}/1.2$ , 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.

$$\text{with } f_{s2} = (f_{s,jacket} * A_{s1,com,jacket} + f_{s,core} * A_{s1,com,core}) / A_{s1,com} = 694.45$$

$$\text{with } E_{s2} = (E_{s,jacket} * A_{s1,com,jacket} + E_{s,core} * A_{s1,com,core}) / A_{s1,com} = 200000.00$$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$f_{tv} = 833.34$$

$$f_{yv} = 694.45$$

$$s_{uv} = 0.032$$

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  $y_v$ ,  $sh_v$ ,  $f_{tv}$ ,  $f_{yv}$ , it is considered  
characteristic value  $f_{syv} = f_{sv}/1.2$ , from table 5.1, TBDY.

$y_1$ ,  $sh_1$ ,  $ft_1$ ,  $f_y1$ , are also multiplied by  $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.

$$\text{with } f_{sv} = (f_{s,jacket} * A_{s1,mid,jacket} + f_{s,mid} * A_{s1,mid,core}) / A_{s1,mid} = 694.45$$

$$\text{with } E_{sv} = (E_{s,jacket} * A_{s1,mid,jacket} + E_{s,mid} * A_{s1,mid,core}) / A_{s1,mid} = 200000.00$$

$$1 = A_{s1,ten} / (b * d) * (f_{s1} / f_c) = 0.10623177$$

$$2 = A_{s1,com} / (b * d) * (f_{s2} / f_c) = 0.05957415$$

$$v = A_{s1,mid} / (b * d) * (f_{sv} / f_c) = 0.03374111$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 34.07073$$

$$c_c (5A.5, TBDY) = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = A_{s1,ten} / (b * d) * (f_{s1} / f_c) = 0.13125889$$

$$2 = A_{s1,com} / (b * d) * (f_{s2} / f_c) = 0.0736092$$

$$v = A_{s1,mid} / (b * d) * (f_{sv} / f_c) = 0.04169017$$

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

--->

$$s_u (4.8) = 0.1403202$$

$$M_u = M_{Rc} (4.15) = 7.4472E+008$$

$$u = s_u (4.1) = 5.9367084E-005$$

-----  
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:

$$u = 5.6088283E-005$$

Mu = 4.3734E+008

with full section properties:

b = 400.00

d = 627.00

d' = 43.00

v = 0.00027032

N = 2237.255

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu:  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00650345$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $cu = 0.00650345$

we (5.4c) = 0.00563796

ase ((5.4d), TBDY) =  $(ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$

ase1 = 0.14776895

bo\_1 = 340.00

ho\_1 = 610.00

bi2\_1 = 975400.00

ase2 =  $\text{Max}(ase1, ase2) = 0.14776895$

bo\_2 = 192.00

ho\_2 = 492.00

bi2\_2 = 557856.00

$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.25908$

$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25223$

ps1 (external) =  $(Ash1 * h1 / s1) / A_{sec} = 0.00261799$

Ash1 =  $A_{stir\_1} * ns_1 = 157.0796$

No stirups,  $ns_1 = 2.00$

h1 = 670.00

ps2 (internal) =  $(Ash2 * h2 / s2) / A_{sec} = 0.00062519$

Ash2 =  $A_{stir\_2} * ns_2 = 100.531$

No stirups,  $ns_2 = 2.00$

h2 = 500.00

$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25908$

ps1 (external) =  $(Ash1 * h1 / s1) / A_{sec} = 0.00156298$

Ash1 =  $A_{stir\_1} * ns_1 = 157.0796$

No stirups,  $ns_1 = 2.00$

h1 = 400.00

ps2 (internal) =  $(Ash2 * h2 / s2) / A_{sec} = 0.00025008$

Ash2 =  $A_{stir\_2} * ns_2 = 100.531$

No stirups,  $ns_2 = 2.00$

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A.5), TBDY), TBDY:  $cc = 0.00232446$

c = confinement factor = 1.03245

y1 = 0.0025

sh1 = 0.008

ft1 = 833.34

fy1 = 694.45

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  $f_{s1} = (f_{s,jacket} \cdot A_{s,ten,jacket} + f_{s,core} \cdot A_{s,ten,core}) / A_{s,ten} = 694.45$   
 with  $E_{s1} = (E_{s,jacket} \cdot A_{s,ten,jacket} + E_{s,core} \cdot A_{s,ten,core}) / A_{s,ten} = 200000.00$   
 $y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$   
 $fy_2 = 694.45$   
 $su_2 = 0.032$   
 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  
 $l_0/l_{ou,min} = l_b/l_{b,min} = 1.00$   
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$   
 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  $f_{s2} = (f_{s,jacket} \cdot A_{s,com,jacket} + f_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 694.45$   
 with  $E_{s2} = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 200000.00$   
 $y_v = 0.0025$   
 $sh_v = 0.008$   
 $ft_v = 833.34$   
 $fy_v = 694.45$   
 $su_v = 0.032$   
 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  
 $l_0/l_{ou,min} = l_b/l_d = 1.00$   
 $su_v = 0.4 \cdot esu_{v,nominal} ((5.5), TBDY) = 0.032$   
 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  $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 694.45$   
 with  $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.05957415$   
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.10623177$   
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.03374111$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.0736092$   
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.13125889$   
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.04169017$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.09006517$   
 $Mu = MRc (4.14) = 4.3734E+008$   
 $u = su (4.1) = 5.6088283E-005$

-----  
 Calculation of ratio  $l_b/l_d$   
 -----

Adequate Lap Length:  $l_b/l_d \geq 1$   
 -----  
 -----  
 -----

Calculation of  $Mu_2$ -  
 -----

Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

$$u = 5.9367084E-005$$

$$Mu = 7.4472E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o(5A.5, TBDY) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00650345$$

$$\phi_{we}(5.4c) = 0.00563796$$

$$a_{se}((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$$

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25223$$

$$p_{s1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25908$$

$$p_{s1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_{cc} = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

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

$$l_o / l_{ou, \min} = l_b / d = 1.00$$

$$su_1 = 0.4 * e_{su1\_nominal}((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY:  $e_{su1\_nominal} = 0.08$ ,

For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered characteristic value  $fsy1 = fs1/1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs1 = (fs_{jacket} \cdot Asl_{ten,jacket} + fs_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 694.45$

with  $Es1 = (Es_{jacket} \cdot Asl_{ten,jacket} + Es_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 200000.00$

$y2 = 0.0025$

$sh2 = 0.008$

$ft2 = 833.34$

$fy2 = 694.45$

$su2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with  $shear\_factor$  and also multiplied by the  $shear\_factor$  according to 15.7.1.4, with  $Shear\_factor = 1.00$

$lo/lo_{ou,min} = lb/lb_{,min} = 1.00$

$su2 = 0.4 \cdot esu2\_nominal ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08$ ,

For calculation of  $esu2\_nominal$  and  $y2, sh2, ft2, fy2$ , it is considered characteristic value  $fsy2 = fs2/1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 694.45$

with  $Es2 = (Es_{jacket} \cdot Asl_{com,jacket} + Es_{core} \cdot Asl_{com,core}) / Asl_{com} = 200000.00$

$yv = 0.0025$

$shv = 0.008$

$ftv = 833.34$

$fyv = 694.45$

$suv = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with  $shear\_factor$  and also multiplied by the  $shear\_factor$  according to 15.7.1.4, with  $Shear\_factor = 1.00$

$lo/lo_{ou,min} = lb/ld = 1.00$

$suv = 0.4 \cdot esuv\_nominal ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY:  $esuv\_nominal = 0.08$ ,

considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY

For calculation of  $esuv\_nominal$  and  $yv, shv, ftv, fyv$ , it is considered characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 694.45$

with  $Es_v = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$

$1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.10623177$

$2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.05957415$

$v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.03374111$

and confined core properties:

$b = 340.00$

$d = 597.00$

$d' = 13.00$

$fcc (5A.2, TBDY) = 34.07073$

$cc (5A.5, TBDY) = 0.00232446$

$c = \text{confinement factor} = 1.03245$

$1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.13125889$

$2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.0736092$

$v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.04169017$

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

--->

$su (4.8) = 0.1403202$

$Mu = MRc (4.15) = 7.4472E+008$

$u = su (4.1) = 5.9367084E-005$

Calculation of ratio  $lb/ld$

Adequate Lap Length:  $lb/ld \geq 1$

-----  
-----  
Calculation of Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 558200.119$

-----  
Calculation of Shear Strength at edge 1,  $V_{r1} = 558200.119$   
 $V_{r1} = V_n$  ((22.5.1.1), ACI 318-14)

-----  
NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f\*Vf'  
where Vf is the contribution of FRPs (11.3), ACI 440).

-----  
From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} * \text{Area}_{jacket} + f'_{c\_core} * \text{Area}_{core}) / \text{Area}_{section} = 33.00$ , but  $f_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)  
 $p_w = A_s / (b_w * d) = 0.00331157$   
As (tension reinf.) = 709.9999  
bw = 400.00  
d = 536.00  
 $V_u * d / \mu < 1 = 1.00$   
 $\mu = 1.0197E+006$   
Vu = 9840.633  
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 349068.643$   
 $V_{s1} = 311834.654$  is calculated for jacket, with:  
d = 536.00  
Av = 157079.633  
fy = 555.56  
s = 150.00  
Vs1 has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 37233.989$  is calculated for jacket, with:  
d2 = 400.00  
Av = 100530.965  
fy = 555.56  
s = 300.00  
Vs2 has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)  
 $2(1-s/d) = 0.50$   
Vf ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

-----  
Calculation of Shear Strength at edge 2,  $V_{r2} = 558200.119$   
 $V_{r2} = V_n$  ((22.5.1.1), ACI 318-14)

-----  
NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f\*Vf'  
where Vf is the contribution of FRPs (11.3), ACI 440).

-----  
From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} * \text{Area}_{jacket} + f'_{c\_core} * \text{Area}_{core}) / \text{Area}_{section} = 33.00$ , but  $f_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)  
 $p_w = A_s / (b_w * d) = 0.00331157$   
As (tension reinf.) = 709.9999  
bw = 400.00  
d = 536.00  
 $V_u * d / \mu < 1 = 1.00$   
 $\mu = 1.0197E+006$   
Vu = 9840.633  
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 349068.643$   
 $V_{s1} = 311834.654$  is calculated for jacket, with:  
d = 536.00  
Av = 157079.633  
fy = 555.56  
s = 150.00  
Vs1 has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 37233.989$  is calculated for jacket, with:  
d = 400.00  
Av = 100530.965  
fy = 555.56

s = 300.00

Vs2 has been multiplied by 2(1-s/d) (s>d/2, according to ASCE 41-17,10.3.4)

2(1-s/d) = 0.50

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: Vs + Vf <= 818179.336

-----  
End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 3

-----  
Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

-----  
Knowledge Factor, = 1.00

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Primary Member: Concrete Strength, fc = fcm = 33.00

New material of Primary Member: Steel Strength, fs = fsm = 555.56

Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00

Existing Column

New material of Primary Member: Concrete Strength, fc = fcm = 33.00

New material of Primary Member: Steel Strength, fs = fsm = 555.56

Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, fs = 1.25\*fsm = 694.45

Existing Column

New material: Steel Strength, fs = 1.25\*fsm = 694.45

#####

External Height, H = 670.00

External Width, W = 400.00

Internal Height, H = 500.00

Internal Width, W = 200.00

Cover Thickness, c = 25.00

Mean Confinement Factor overall section = 1.03245

Element Length, L = 3000.00

Primary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length (lo/lo, min >= 1)

No FRP Wrapping

-----  
Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, Va = -6.9721474E-015

EDGE -B-

Shear Force, Vb = 6.9721474E-015

BOTH EDGES

Axial Force, F = -2237.255

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: Aslt = 709.9999

-Compression: Asl,c = 1668.186  
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension: Asl,t = 911.0619  
-Compression: Asl,c = 911.0619  
-Middle: Asl,m = 556.0619

Calculation of Shear Capacity ratio ,  $V_e/V_r = 0.53480887$

Member Controlled by Flexure ( $V_e/V_r < 1$ )

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 204955.561$   
with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 3.0743E+008$

$M_{u1+} = 3.0743E+008$ , 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

$M_{u1-} = 3.0743E+008$ , 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

$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 3.0743E+008$

$M_{u2+} = 3.0743E+008$ , 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

$M_{u2-} = 3.0743E+008$ , 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

$V_1 = -6.9721474E-015$ , is the shear force acting at edge 1 for the the static loading combination

$V_2 = 6.9721474E-015$ , is the shear force acting at edge 2 for the the static loading combination

Calculation of  $M_{u1+}$

Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

$\phi_u = 0.00010406$

$M_u = 3.0743E+008$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$f_c = 33.00$

$\phi_c$  (5A.5, TBDY) = 0.002

Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00650345$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $\phi_u = 0.00650345$

$w_e$  (5.4c) = 0.00563796

$a_{se}$  ((5.4d), TBDY) =  $(a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int})/A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o1} = 340.00$

$h_{o1} = 610.00$

$b_{i21} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o2} = 192.00$

$h_{o2} = 492.00$

$b_{i22} = 557856.00$

$p_{sh, \min} \cdot F_{ywe} = \text{Min}(p_{sh, x} \cdot F_{ywe}, p_{sh, y} \cdot F_{ywe}) = 1.25908$

$p_{sh, x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{sh2} \cdot F_{ywe2} = 2.25223$

$p_{s1}$  (external) =  $(A_{sh1} \cdot h_1/s_1)/A_{sec} = 0.00261799$

$A_{sh1} = A_{stir, 1} \cdot n_{s, 1} = 157.0796$

No stirups,  $n_{s, 1} = 2.00$

$h_1 = 670.00$

$p_{s2}$  (internal) =  $(A_{sh2} \cdot h_2/s_2)/A_{sec} = 0.00062519$

Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00156298  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 400.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00025008  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00232446

c = confinement factor = 1.03245

y1 = 0.0025

sh1 = 0.008

ft1 = 833.34

fy1 = 694.45

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 = 694.45

with Es1 = (Es,jacket\*Asl,ten,jacket + Es,core\*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025

sh2 = 0.008

ft2 = 833.34

fy2 = 694.45

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 = 694.45

with Es2 = (Es,jacket\*Asl,com,jacket + Es,core\*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 833.34

fyv = 694.45

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  $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 694.45$

with  $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.08015524$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.08015524$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.04892233$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

$f_{cc} (5A.2, TBDY) = 34.07073$

$cc (5A.5, TBDY) = 0.00232446$

$c = \text{confinement factor} = 1.03245$

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.09611636$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.09611636$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.05866412$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

$v < v_{s,c}$  - RHS eq.(4.5) is satisfied

---->

$su (4.9) = 0.13857861$

$Mu = MRc (4.14) = 3.0743E+008$

$u = su (4.1) = 0.00010406$

-----  
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:

$u = 0.00010406$

$Mu = 3.0743E+008$   
-----

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$f_c = 33.00$

$co (5A.5, TBDY) = 0.002$

Final value of  $cu$ :  $cu^* = \text{shear\_factor} \cdot \text{Max}(cu, cc) = 0.00650345$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $cu = 0.00650345$

we (5.4c) = 0.00563796

ase ((5.4d), TBDY) =  $(ase_1 \cdot A_{ext} + ase_2 \cdot A_{int}) / A_{sec} = 0.14776895$

ase1 = 0.14776895

bo\_1 = 340.00

ho\_1 = 610.00

bi2\_1 = 975400.00

ase2 =  $\text{Max}(ase_1, ase_2) = 0.14776895$

bo\_2 = 192.00

ho\_2 = 492.00

bi2\_2 = 557856.00

$psh_{min} \cdot F_{ywe} = \text{Min}(psh_x \cdot F_{ywe}, psh_y \cdot F_{ywe}) = 1.25908$

-----  
 $psh_x \cdot F_{ywe} = psh_1 \cdot F_{ywe1} + ps_2 \cdot F_{ywe2} = 2.25223$

ps1 (external) =  $(Ash_1 \cdot h_1 / s_1) / A_{sec} = 0.00261799$

$Ash_1 = Astir_1 \cdot ns_1 = 157.0796$

No stirups,  $ns_1 = 2.00$   
 $h1 = 670.00$   
 $ps2$  (internal) =  $(Ash2 \cdot h2 / s2) / Asec = 0.00062519$   
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$   
No stirups,  $ns_2 = 2.00$   
 $h2 = 500.00$

-----  
 $psh_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.25908$   
 $ps1$  (external) =  $(Ash1 \cdot h1 / s1) / Asec = 0.00156298$   
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$   
No stirups,  $ns_1 = 2.00$   
 $h1 = 400.00$   
 $ps2$  (internal) =  $(Ash2 \cdot h2 / s2) / Asec = 0.00025008$   
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$   
No stirups,  $ns_2 = 2.00$   
 $h2 = 200.00$

-----  
 $Asec = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fywe1 = 694.45$   
 $fywe2 = 694.45$   
 $fce = 33.00$

From ((5.A.5), TBDY), TBDY:  $cc = 0.00232446$   
 $c =$  confinement factor = 1.03245

$y1 = 0.0025$   
 $sh1 = 0.008$   
 $ft1 = 833.34$   
 $fy1 = 694.45$   
 $su1 = 0.032$

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  $Min(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs1 = (fs,jacket \cdot Asl,ten,jacket + fs,core \cdot Asl,ten,core) / Asl,ten = 694.45$

with  $Es1 = (Es,jacket \cdot Asl,ten,jacket + Es,core \cdot Asl,ten,core) / Asl,ten = 200000.00$

$y2 = 0.0025$   
 $sh2 = 0.008$   
 $ft2 = 833.34$   
 $fy2 = 694.45$   
 $su2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$lo/lou,min = lb/lb,min = 1.00$

$su2 = 0.4 \cdot esu2\_nominal$  ((5.5), TBDY) = 0.032

From table 5A.1, TBDY:  $esu2\_nominal = 0.08$ ,

For calculation of  $esu2\_nominal$  and  $y2, sh2, ft2, fy2$ , it is considered  
characteristic value  $fsy2 = fs2 / 1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs2 = (fs,jacket \cdot Asl,com,jacket + fs,core \cdot Asl,com,core) / Asl,com = 694.45$

with  $Es2 = (Es,jacket \cdot Asl,com,jacket + Es,core \cdot Asl,com,core) / Asl,com = 200000.00$

$yv = 0.0025$   
 $shv = 0.008$   
 $ftv = 833.34$   
 $fyv = 694.45$   
 $suv = 0.032$

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  $fsv = fsv/1.2$ , 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.  
 $y1, sh1,ft1,fy1$ , are also multiplied by  $Min(1,1.25*(lb/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs_{jacket}*Asl_{mid,jacket} + fs_{mid}*Asl_{mid,core})/Asl_{mid} = 694.45$   
 with  $Esv = (Es_{jacket}*Asl_{mid,jacket} + Es_{mid}*Asl_{mid,core})/Asl_{mid} = 200000.00$   
 $1 = Asl_{ten}/(b*d)*(fs1/fc) = 0.08015524$   
 $2 = Asl_{com}/(b*d)*(fs2/fc) = 0.08015524$   
 $v = Asl_{mid}/(b*d)*(fsv/fc) = 0.04892233$

and confined core properties:

$b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc$  (5A.2, TBDY) = 34.07073  
 $cc$  (5A.5, TBDY) = 0.00232446  
 $c =$  confinement factor = 1.03245  
 $1 = Asl_{ten}/(b*d)*(fs1/fc) = 0.09611636$   
 $2 = Asl_{com}/(b*d)*(fs2/fc) = 0.09611636$   
 $v = Asl_{mid}/(b*d)*(fsv/fc) = 0.05866412$

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) = 0.13857861  
 $Mu = MRc$  (4.14) = 3.0743E+008  
 $u = su$  (4.1) = 0.00010406

-----  
 Calculation of ratio  $lb/l_d$

-----  
 Adequate Lap Length:  $lb/l_d \geq 1$   
 -----

-----  
 Calculation of  $Mu_{2+}$   
 -----

-----  
 Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:

$u = 0.00010406$   
 $Mu = 3.0743E+008$

-----  
 with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $fc = 33.00$   
 $co$  (5A.5, TBDY) = 0.002  
 Final value of  $cu$ :  $cu^* = shear\_factor * Max(cu, cc) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00650345$   
 $w_e$  (5.4c) = 0.00563796  
 $ase$  ((5.4d), TBDY) =  $(ase1*A_{ext} + ase2*A_{int})/A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo\_1 = 340.00$   
 $ho\_1 = 610.00$   
 $bi2\_1 = 975400.00$   
 $ase2 = Max(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$   
 $psh_{min}*Fy_{we} = Min(psh_x*Fy_{we}, psh_y*Fy_{we}) = 1.25908$

psh\_x\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 2.25223  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00261799  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 670.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00062519  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00156298  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 400.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00025008  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00232446

c = confinement factor = 1.03245

y1 = 0.0025

sh1 = 0.008

ft1 = 833.34

fy1 = 694.45

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  $\text{Min}(1, 1.25 * (\text{lb}/\text{ld})^{2/3})$ , from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket\*Asl,ten,jacket + fs,core\*Asl,ten,core)/Asl,ten = 694.45

with Es1 = (Es,jacket\*Asl,ten,jacket + Es,core\*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025

sh2 = 0.008

ft2 = 833.34

fy2 = 694.45

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  $\text{Min}(1, 1.25 * (\text{lb}/\text{ld})^{2/3})$ , from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket\*Asl,com,jacket + fs,core\*Asl,com,core)/Asl,com = 694.45

with Es2 = (Es,jacket\*Asl,com,jacket + Es,core\*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 833.34

fyv = 694.45

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

su = 0.4\*esuv\_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv\_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv\_nominal and yv, shv,ftv,fyv, it is considered characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25\*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.

with fsv = (fsjacket\*Asl,mid,jacket + fs,mid\*Asl,mid,core)/Asl,mid = 694.45

with Esv = (Es,jacket\*Asl,mid,jacket + Es,mid\*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.08015524

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.08015524

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.04892233

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07073

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.09611636

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.09611636

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.05866412

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) = 0.13857861

Mu = MRc (4.14) = 3.0743E+008

u = su (4.1) = 0.00010406

-----  
Calculation of ratio lb/d

-----  
Adequate Lap Length: lb/d >= 1

-----  
Calculation of Mu2-

-----  
Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 0.00010406

Mu = 3.0743E+008

-----  
with full section properties:

b = 670.00

d = 357.00

d' = 43.00

v = 0.00028344

N = 2237.255

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu: cu\* = shear\_factor \* Max( cu, cc) = 0.00650345

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.00650345

we (5.4c) = 0.00563796

ase ((5.4d), TBDY) = (ase1\*Aext+ase2\*Aint)/Asec = 0.14776895

ase1 = 0.14776895

bo\_1 = 340.00

ho\_1 = 610.00

bi2\_1 = 975400.00

ase2 = Max(ase1,ase2) = 0.14776895

bo\_2 = 192.00

ho\_2 = 492.00

$$bi2\_2 = 557856.00$$
$$psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.25908$$

$$psh\_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.25223$$
$$ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00261799$$
$$Ash1 = Astir\_1*ns\_1 = 157.0796$$
$$\text{No stirups, } ns\_1 = 2.00$$
$$h1 = 670.00$$
$$ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00062519$$
$$Ash2 = Astir\_2*ns\_2 = 100.531$$
$$\text{No stirups, } ns\_2 = 2.00$$
$$h2 = 500.00$$

$$psh\_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.25908$$
$$ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00156298$$
$$Ash1 = Astir\_1*ns\_1 = 157.0796$$
$$\text{No stirups, } ns\_1 = 2.00$$
$$h1 = 400.00$$
$$ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00025008$$
$$Ash2 = Astir\_2*ns\_2 = 100.531$$
$$\text{No stirups, } ns\_2 = 2.00$$
$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 694.45$$

$$fce = 33.00$$

$$\text{From } ((5.A.5), \text{ TBDY}), \text{ TBDY: } cc = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 833.34$$

$$fy1 = 694.45$$

$$su1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou,min = lb/l_d = 1.00$$

$$su1 = 0.4*esu1\_nominal \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu1\_nominal = 0.08,$$

For calculation of esu1\_nominal and y1, sh1, ft1, fy1, it is considered  
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25*(lb/l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45$$

$$\text{with } Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 833.34$$

$$fy2 = 694.45$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou,min = lb/l_b,min = 1.00$$

$$su2 = 0.4*esu2\_nominal \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu2\_nominal = 0.08,$$

For calculation of esu2\_nominal and y2, sh2, ft2, fy2, it is considered  
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25*(lb/l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45$$

$$\text{with } Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 833.34$$

$$fyv = 694.45$$

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 = (fsjacket\*Asl,mid,jacket + fs,mid\*Asl,mid,core)/Asl,mid = 694.45

with Esv = (Es,jacket\*Asl,mid,jacket + Es,mid\*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.08015524

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.08015524

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.04892233

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07073

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.09611636

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.09611636

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.05866412

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) = 0.13857861

Mu = MRc (4.14) = 3.0743E+008

u = su (4.1) = 0.00010406

-----  
Calculation of ratio lb/d

-----  
Adequate Lap Length: lb/d >= 1  
-----  
-----

-----  
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 383231.42  
-----

Calculation of Shear Strength at edge 1, Vr1 = 383231.42

Vr1 = Vn ((22.5.1.1), ACI 318-14)

-----  
NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f\*Vf'  
where Vf is the contribution of FRPs (11.3), ACI 440).  
-----

From Table (22.5.5.1), ACI 318-14: Vc = 197061.477

= 1 (normal-weight concrete)

Mean concrete strength: fc' = (fc'\_jacket\*Area\_jacket + fc'\_core\*Area\_core)/Area\_section = 33.00, but  $fc'^{0.5} \leq 8.3$   
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 = 8.6547052E-012

Vu = 6.9721474E-015

From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 186169.943

Vs1 = 186169.943 is calculated for jacket, with:

d = 320.00

Av = 157079.633

fy = 555.56

s = 150.00

Vs1 has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

Vs2 = 0.00 is calculated for jacket, with:

d2 = 160.00

Av = 100530.965

fy = 555.56

s = 300.00

Vs2 is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

-----  
Calculation of Shear Strength at edge 2, Vr2 = 383231.42

Vr2 = Vn ((22.5.1.1), ACI 318-14)

-----  
NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f\*Vf'  
where Vf is the contribution of FRPs (11.3), ACI 440).

-----  
From Table (22.5.5.1), ACI 318-14: Vc = 197061.477

= 1 (normal-weight concrete)

Mean concrete strength:  $f_c' = (f_c'_{jacket} * Area_{jacket} + f_c'_{core} * Area_{core}) / Area_{section} = 33.00$ , but  $f_c'^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)

pw = As/(bw\*d) = 0.00331157

As (tension reinf.) = 709.9999

bw = 670.00

d = 320.00

Vu\*d/Mu < 1 = 0.00

Mu = 1.2266780E-011

Vu = 6.9721474E-015

From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 186169.943

Vs1 = 186169.943 is calculated for jacket, with:

d = 320.00

Av = 157079.633

fy = 555.56

s = 150.00

Vs1 has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

Vs2 = 0.00 is calculated for jacket, with:

d = 160.00

Av = 100530.965

fy = 555.56

s = 300.00

Vs2 is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

-----  
End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

-----  
Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

-----  
Knowledge Factor, = 1.00

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$   
New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$   
Concrete Elasticity,  $E_c = 26999.444$   
Steel Elasticity,  $E_s = 200000.00$   
External Height,  $H = 670.00$   
External Width,  $W = 400.00$   
Internal Height,  $H = 500.00$   
Internal Width,  $W = 200.00$   
Cover Thickness,  $c = 25.00$   
Element Length,  $L = 3000.00$   
Primary Member  
Smooth Bars  
Ductile Steel  
With Detailing for Earthquake Resistance (including stirrups closed at  $135^\circ$ )  
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,  $M = 1.0660E+007$   
Shear Force,  $V_2 = 5.6924552E-014$   
Shear Force,  $V_3 = 15660.977$   
Axial Force,  $F = -3615.233$   
Longitudinal Reinforcement Area Distribution (in 2 divisions)  
-Tension:  $A_{st} = 709.9999$   
-Compression:  $A_{sc} = 1668.186$   
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $A_{st,ten} = 709.9999$   
-Compression:  $A_{sc,com} = 1266.062$   
-Middle:  $A_{sc,mid} = 402.1239$   
Longitudinal External Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $A_{st,ten,jacket} = 402.1239$   
-Compression:  $A_{sc,com,jacket} = 804.2477$   
-Middle:  $A_{sc,mid,jacket} = 402.1239$   
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $A_{st,ten,core} = 307.8761$   
-Compression:  $A_{sc,com,core} = 461.8141$   
-Middle:  $A_{sc,mid,core} = 0.00$   
Mean Diameter of Tension Reinforcement,  $DbL = 15.00$   
-----

-----  
New component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u_{,R} = 1.0^*$   $u = 0.0507643$   
 $u = y + p = 0.0507643$

-----  
- Calculation of  $y$  -  
-----

$y = (M_y * L_s / 3) / E_{eff} = 0.0007643$  ((4.29), Biskinis Phd))  
 $M_y = 2.7353E+008$   
 $L_s = M/V$  (with  $L_s > 0.1 * L$  and  $L_s < 2 * L$ ) =  $680.6998$   
From table 10.5, ASCE 41\_17:  $E_{eff} = 0.3 * E_c * I_g = 8.1204E+013$   
-----

-----  
Calculation of Yielding Moment  $M_y$   
-----

Calculation of  $y$  and  $M_y$  according to Annex 7 -  
-----

$y = \text{Min}(y_{ten}, y_{com})$   
 $y_{ten} = 5.4341296E-006$   
with  $f_y = 555.56$   
 $d = 627.00$   
 $y = 0.18472628$

A = 0.00950835  
 B = 0.00405975  
 with pt = 0.00283094  
   pc = 0.00504809  
   pv = 0.00160336  
   N = 3615.233  
   b = 400.00  
   " = 0.06858054  
 y\_comp = 1.9040134E-005  
 with fc = 33.00  
   Ec = 26999.444  
   y = 0.18428673  
   A = 0.00944964  
   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 = 0.05

with:

- Condition i occurred

Beam controlled by flexure:  $V_p/V_o \leq 1$

shear control ratio  $V_p/V_o = 0.90705729$

- Transverse Reinforcement: C

- Stirrup Spacing  $\leq d/3$

- Low ductility demand,  $\lambda < 2$  (table 10-6, ASCE 41-17)

= -1.1948219E-006

- Stirrup Spacing  $\leq d/2$

d = d\_external = 627.00

s = s\_external = 150.00

- Strength provided by hoops  $V_s < 3/4$ \*design Shear

$V_s = 386302.632$ , already given in calculation of shear control ratio

design Shear = 15660.977

- ( - ')/ bal = -0.22420649

=  $A_{st}/(b_w*d) = 0.00283094$

Tension Reinf Area:  $A_{st} = 709.9999$

' =  $A_{sc}/(b_w*d) = 0.00665146$

Compression Reinf Area:  $A_{sc} = 1668.186$

From (B-1), ACI 318-11: bal = 0.01704017

$f_c = (f_{c\_jacket}*Area\_jacket + f_{c\_core}*Area\_core)/section\_area = 33.00$

$f_y = f_{y\_jacket\_bars} = 555.56$

From 10.2.7.3, ACI 318-11:  $\lambda = 0.65$

From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + \lambda) = 0.51922877$

$\lambda = 0.0027778$

-  $V/(b_w*d*f_c^{0.5}) = 0.13090541$ , 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

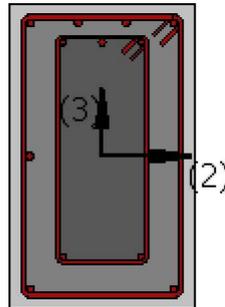
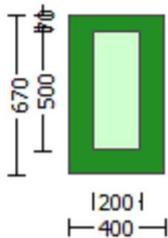
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity  $VR_d$

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,  $\gamma = 1.00$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups closed at  $135^\circ$ )

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,  $M_a = 6.8008E+006$

Shear Force,  $V_a = 4020.289$

EDGE -B-

Bending Moment,  $M_b = 1.0660E+007$

Shear Force,  $V_b = 15660.977$

BOTH EDGES

Axial Force,  $F = -3615.233$

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:  $As_{t, \text{ten}} = 709.9999$

-Compression:  $As_{c, \text{com}} = 1266.062$

-Middle:  $As_{c, \text{mid}} = 402.1239$

Mean Diameter of Tension Reinforcement,  $Db_{L, \text{ten}} = 15.00$

-----  
New component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $V_R = 1.0 \cdot V_n = 495183.483$

$V_n$  ((22.5.1.1), ACI 318-14) = 495183.483

-----  
NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw + f\*Vf'  
where Vf is the contribution of FRPs (11.3), ACI 440).

-----  
From Table (22.5.5.1), ACI 318-14:  $V_c = 181024.218$

= 1 (normal-weight concrete)

Mean concrete strength:  $f'_c = (f'_{c, \text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_{c, \text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 25.00$ , but  $f'_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)

$\rho_w = A_s / (b_w \cdot d) = 0.00331157$

$A_s$  (tension reinf.) = 709.9999

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / M_u < 1 = 0.78742491$

$M_u = 1.0660E+007$

$V_u = 15660.977$

From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 314159.265$

$V_{s1} = 280648.944$  is calculated for jacket, with:

$d = 536.00$

$A_v = 157079.633$

$f_y = 500.00$

$s = 150.00$

$V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

$V_{s2} = 33510.322$  is calculated for core, with:

$d = 400.00$

$A_v = 100530.965$

$f_y = 500.00$

$s = 300.00$

$V_{s2}$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

$V_f$  ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440:  $V_s + V_f \leq 712133.705$

-----  
End Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)

## Calculation No. 16

beam B1, Floor 1

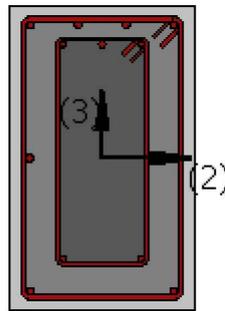
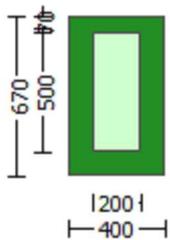
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity ( $\theta_r$ )

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$

Existing Column

New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$   
Mean Confinement Factor overall section = 1.03245  
Element Length,  $L = 3000.00$   
Primary Member  
Smooth Bars  
Ductile Steel  
With Detailing for Earthquake Resistance (including stirrups closed at  $135^\circ$ )  
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,  $V_a = 9840.633$   
EDGE -B-  
Shear Force,  $V_b = 9840.633$   
BOTH EDGES  
Axial Force,  $F = -2237.255$   
Longitudinal Reinforcement Area Distribution (in 2 divisions)  
-Tension:  $A_{st} = 709.9999$   
-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,  $V_e/V_r = 0.90705729$   
Member Controlled by Flexure ( $V_e/V_r < 1$ )  
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 506319.489$   
with  
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 7.4472E+008$   
 $\mu_{u1+} = 4.3734E+008$ , 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  
 $\mu_{u1-} = 7.4472E+008$ , is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination  
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 7.4472E+008$   
 $\mu_{u2+} = 4.3734E+008$ , 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  
 $\mu_{u2-} = 7.4472E+008$ , is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination  
and  
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$   
with  
 $V_1 = 9840.633$ , is the shear force acting at edge 1 for the static loading combination  
 $V_2 = 9840.633$ , is the shear force acting at edge 2 for the static loading combination

-----  
Calculation of  $\mu_{u1+}$   
-----

-----  
Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:  
 $\phi_u = 5.6088283E-005$   
 $\mu_u = 4.3734E+008$   
-----

with full section properties:  
 $b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu:  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00650345$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $cu = 0.00650345$

we (5.4c) = 0.00563796

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

$psh_{min} * Fy_{we} = \text{Min}(psh_x * Fy_{we}, psh_y * Fy_{we}) = 1.25908$

$psh_x * Fy_{we} = psh1 * Fy_{we1} + ps2 * Fy_{we2} = 2.25223$

ps1 (external) =  $(Ash1 * h1 / s1) / A_{sec} = 0.00261799$

Ash1 =  $A_{stir\_1} * ns_1 = 157.0796$

No stirups,  $ns_1 = 2.00$

h1 = 670.00

ps2 (internal) =  $(Ash2 * h2 / s2) / A_{sec} = 0.00062519$

Ash2 =  $A_{stir\_2} * ns_2 = 100.531$

No stirups,  $ns_2 = 2.00$

h2 = 500.00

$psh_y * Fy_{we} = psh1 * Fy_{we1} + ps2 * Fy_{we2} = 1.25908$

ps1 (external) =  $(Ash1 * h1 / s1) / A_{sec} = 0.00156298$

Ash1 =  $A_{stir\_1} * ns_1 = 157.0796$

No stirups,  $ns_1 = 2.00$

h1 = 400.00

ps2 (internal) =  $(Ash2 * h2 / s2) / A_{sec} = 0.00025008$

Ash2 =  $A_{stir\_2} * ns_2 = 100.531$

No stirups,  $ns_2 = 2.00$

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A5), TBDY), TBDY:  $cc = 0.00232446$

c = confinement factor = 1.03245

y1 = 0.0025

sh1 = 0.008

ft1 = 833.34

fy1 = 694.45

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.

with  $fs1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 694.45$

with  $Es1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$

y2 = 0.0025

sh2 = 0.008

ft2 = 833.34

fy2 = 694.45

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 = 694.45

with Es2 = (Es,jacket\*Asl,com,jacket + Es,core\*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 833.34

fyv = 694.45

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 = 694.45

with Esv = (Es,jacket\*Asl,mid,jacket + Es,mid\*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.05957415

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.10623177

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.03374111

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07073

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.0736092

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.13125889

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.04169017

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

v < vs,y2 - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.09006517

Mu = MRc (4.14) = 4.3734E+008

u = su (4.1) = 5.6088283E-005

-----  
Calculation of ratio lb/ld

-----  
Adequate Lap Length: lb/ld >= 1

-----  
Calculation of Mu1-

-----  
Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 5.9367084E-005

Mu = 7.4472E+008

-----  
with full section properties:

b = 400.00

d = 627.00

$d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $co (5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = shear\_factor * Max(cu, cc) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00650345$   
 $w_e (5.4c) = 0.00563796$   
 $ase ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo_1 = 340.00$   
 $ho_1 = 610.00$   
 $bi2_1 = 975400.00$   
 $ase2 = Max(ase1, ase2) = 0.14776895$   
 $bo_2 = 192.00$   
 $ho_2 = 492.00$   
 $bi2_2 = 557856.00$   
 $psh, min * F_{ywe} = Min(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.25908$

$psh, x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25223$   
 $ps1 (external) = (Ash1 * h1 / s1) / A_{sec} = 0.00261799$   
 $Ash1 = Astir_1 * ns_1 = 157.0796$   
 No stirups,  $ns_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 (internal) = (Ash2 * h2 / s2) / A_{sec} = 0.00062519$   
 $Ash2 = Astir_2 * ns_2 = 100.531$   
 No stirups,  $ns_2 = 2.00$   
 $h2 = 500.00$

$psh, y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25908$   
 $ps1 (external) = (Ash1 * h1 / s1) / A_{sec} = 0.00156298$   
 $Ash1 = Astir_1 * ns_1 = 157.0796$   
 No stirups,  $ns_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 (internal) = (Ash2 * h2 / s2) / A_{sec} = 0.00025008$   
 $Ash2 = Astir_2 * ns_2 = 100.531$   
 No stirups,  $ns_2 = 2.00$   
 $h2 = 200.00$

$A_{sec} = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $f_{ywe1} = 694.45$   
 $f_{ywe2} = 694.45$   
 $f_c = 33.00$

From ((5.A5), TBDY), TBDY:  $cc = 0.00232446$   
 $c = confinement\ factor = 1.03245$

$y1 = 0.0025$   
 $sh1 = 0.008$   
 $ft1 = 833.34$   
 $fy1 = 694.45$   
 $su1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $Shear\_factor = 1.00$

$lo/lo_{u,min} = lb/ld = 1.00$

$su1 = 0.4 * esu1\_nominal ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,

For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered  
 characteristic value  $fsy1 = fs1 / 1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs1 = (fs, jacket * A_{sl, ten, jacket} + fs, core * A_{sl, ten, core}) / A_{sl, ten} = 694.45$

with  $Es1 = (Es, jacket * A_{sl, ten, jacket} + Es, core * A_{sl, ten, core}) / A_{sl, ten} = 200000.00$

$y2 = 0.0025$   
 $sh2 = 0.008$   
 $ft2 = 833.34$

$$f_y2 = 694.45$$

$$s_u2 = 0.032$$

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

$$l_o/l_{o,min} = l_b/l_{b,min} = 1.00$$

$$s_u2 = 0.4 * e_{su2,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY:  $e_{su2,nominal} = 0.08$ ,

For calculation of  $e_{su2,nominal}$  and  $y_2$ ,  $sh_2$ ,  $ft_2$ ,  $f_y2$ , it is considered  
characteristic value  $f_{sy2} = f_{s2}/1.2$ , 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.

$$\text{with } f_{s2} = (f_{s,jacket} * A_{s1,com,jacket} + f_{s,core} * A_{s1,com,core}) / A_{s1,com} = 694.45$$

$$\text{with } E_{s2} = (E_{s,jacket} * A_{s1,com,jacket} + E_{s,core} * A_{s1,com,core}) / A_{s1,com} = 200000.00$$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$f_{tv} = 833.34$$

$$f_{yv} = 694.45$$

$$s_{uv} = 0.032$$

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

$$l_o/l_{o,min} = l_b/l_d = 1.00$$

$$s_{uv} = 0.4 * e_{suv,nominal} ((5.5), TBDY) = 0.032$$

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  $y_v$ ,  $sh_v$ ,  $f_{tv}$ ,  $f_{yv}$ , it is considered  
characteristic value  $f_{syv} = f_{sv}/1.2$ , from table 5.1, TBDY.

$y_1$ ,  $sh_1$ ,  $ft_1$ ,  $f_y1$ , are also multiplied by  $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.

$$\text{with } f_{sv} = (f_{s,jacket} * A_{s1,mid,jacket} + f_{s,mid} * A_{s1,mid,core}) / A_{s1,mid} = 694.45$$

$$\text{with } E_{sv} = (E_{s,jacket} * A_{s1,mid,jacket} + E_{s,mid} * A_{s1,mid,core}) / A_{s1,mid} = 200000.00$$

$$1 = A_{s1,ten} / (b * d) * (f_{s1} / f_c) = 0.10623177$$

$$2 = A_{s1,com} / (b * d) * (f_{s2} / f_c) = 0.05957415$$

$$v = A_{s1,mid} / (b * d) * (f_{sv} / f_c) = 0.03374111$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 34.07073$$

$$c_c (5A.5, TBDY) = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = A_{s1,ten} / (b * d) * (f_{s1} / f_c) = 0.13125889$$

$$2 = A_{s1,com} / (b * d) * (f_{s2} / f_c) = 0.0736092$$

$$v = A_{s1,mid} / (b * d) * (f_{sv} / f_c) = 0.04169017$$

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

--->

$$s_u (4.8) = 0.1403202$$

$$M_u = M_{Rc} (4.15) = 7.4472E+008$$

$$u = s_u (4.1) = 5.9367084E-005$$

-----  
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:

$$u = 5.6088283E-005$$

Mu = 4.3734E+008

with full section properties:

b = 400.00

d = 627.00

d' = 43.00

v = 0.00027032

N = 2237.255

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu:  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00650345$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $cu = 0.00650345$

we (5.4c) = 0.00563796

ase ((5.4d), TBDY) =  $(ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$

ase1 = 0.14776895

bo\_1 = 340.00

ho\_1 = 610.00

bi2\_1 = 975400.00

ase2 =  $\text{Max}(ase1, ase2) = 0.14776895$

bo\_2 = 192.00

ho\_2 = 492.00

bi2\_2 = 557856.00

$psh, \min * F_{ywe} = \text{Min}(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.25908$

$psh, x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25223$

ps1 (external) =  $(Ash1 * h1 / s1) / A_{sec} = 0.00261799$

Ash1 =  $A_{stir,1} * ns_1 = 157.0796$

No stirups,  $ns_1 = 2.00$

h1 = 670.00

ps2 (internal) =  $(Ash2 * h2 / s2) / A_{sec} = 0.00062519$

Ash2 =  $A_{stir,2} * ns_2 = 100.531$

No stirups,  $ns_2 = 2.00$

h2 = 500.00

$psh, y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25908$

ps1 (external) =  $(Ash1 * h1 / s1) / A_{sec} = 0.00156298$

Ash1 =  $A_{stir,1} * ns_1 = 157.0796$

No stirups,  $ns_1 = 2.00$

h1 = 400.00

ps2 (internal) =  $(Ash2 * h2 / s2) / A_{sec} = 0.00025008$

Ash2 =  $A_{stir,2} * ns_2 = 100.531$

No stirups,  $ns_2 = 2.00$

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A.5), TBDY), TBDY:  $cc = 0.00232446$

c = confinement factor = 1.03245

y1 = 0.0025

sh1 = 0.008

ft1 = 833.34

fy1 = 694.45

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  $f_{s1} = (f_{s,jacket} \cdot A_{s,ten,jacket} + f_{s,core} \cdot A_{s,ten,core}) / A_{s,ten} = 694.45$   
 with  $E_{s1} = (E_{s,jacket} \cdot A_{s,ten,jacket} + E_{s,core} \cdot A_{s,ten,core}) / A_{s,ten} = 200000.00$   
 $y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$   
 $fy_2 = 694.45$   
 $su_2 = 0.032$   
 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  
 $l_0/l_{ou,min} = l_b/l_{b,min} = 1.00$   
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$   
 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  $f_{s2} = (f_{s,jacket} \cdot A_{s,com,jacket} + f_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 694.45$   
 with  $E_{s2} = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 200000.00$   
 $y_v = 0.0025$   
 $sh_v = 0.008$   
 $ft_v = 833.34$   
 $fy_v = 694.45$   
 $suv = 0.032$   
 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  
 $l_0/l_{ou,min} = l_b/l_d = 1.00$   
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$   
 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  $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 694.45$   
 with  $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.05957415$   
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.10623177$   
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.03374111$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.0736092$   
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.13125889$   
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.04169017$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.09006517$   
 $Mu = MRc (4.14) = 4.3734E+008$   
 $u = su (4.1) = 5.6088283E-005$

-----  
 Calculation of ratio  $l_b/l_d$   
 -----

Adequate Lap Length:  $l_b/l_d \geq 1$   
 -----  
 -----  
 -----

Calculation of  $Mu_2$ -  
 -----

Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

$$u = 5.9367084E-005$$

$$Mu = 7.4472E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o(5A.5, TBDY) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00650345$$

$$\phi_{we}(5.4c) = 0.00563796$$

$$a_{se}((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$$

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25223$$

$$p_{s1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

No stirups,  $n_{s\_1} = 2.00$

$$h_1 = 670.00$$

$$p_{s2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

No stirups,  $n_{s\_2} = 2.00$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25908$$

$$p_{s1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

No stirups,  $n_{s\_1} = 2.00$

$$h_1 = 400.00$$

$$p_{s2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

No stirups,  $n_{s\_2} = 2.00$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_{cc} = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

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

$$l_o / l_{ou, \min} = l_b / d = 1.00$$

$$su_1 = 0.4 * esu_{1, \text{nominal}}((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY:  $esu_{1, \text{nominal}} = 0.08$ ,

For calculation of  $es_{u1\_nominal}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered characteristic value  $fs_{y1} = fs_1/1.2$ , 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  $fs_1 = (fs_{jacket} \cdot A_{sl,ten,jacket} + fs_{core} \cdot A_{sl,ten,core}) / A_{sl,ten} = 694.45$

with  $Es_1 = (Es_{jacket} \cdot A_{sl,ten,jacket} + Es_{core} \cdot A_{sl,ten,core}) / A_{sl,ten} = 200000.00$

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 833.34$$

$$fy_2 = 694.45$$

$$su_2 = 0.032$$

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

$$lo/lo_{ou,min} = lb/lb_{,min} = 1.00$$

$$su_2 = 0.4 \cdot es_{u2\_nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY:  $es_{u2\_nominal} = 0.08$ ,

For calculation of  $es_{u2\_nominal}$  and  $y_2, sh_2, ft_2, fy_2$ , it is considered characteristic value  $fs_{y2} = fs_2/1.2$ , from table 5.1, TBDY.

$y_2, sh_2, ft_2, fy_2$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs_2 = (fs_{jacket} \cdot A_{sl,com,jacket} + fs_{core} \cdot A_{sl,com,core}) / A_{sl,com} = 694.45$

with  $Es_2 = (Es_{jacket} \cdot A_{sl,com,jacket} + Es_{core} \cdot A_{sl,com,core}) / A_{sl,com} = 200000.00$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 833.34$$

$$fy_v = 694.45$$

$$su_v = 0.032$$

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

$$lo/lo_{ou,min} = lb/ld = 1.00$$

$$su_v = 0.4 \cdot es_{uv\_nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY:  $es_{uv\_nominal} = 0.08$ ,

considering characteristic value  $fs_{yv} = f_{sv}/1.2$ , from table 5.1, TBDY

For calculation of  $es_{uv\_nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered characteristic value  $fs_{yv} = f_{sv}/1.2$ , from table 5.1, TBDY.

$y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $f_{sv} = (f_{s,jacket} \cdot A_{sl,mid,jacket} + f_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 694.45$

with  $Es_v = (Es_{jacket} \cdot A_{sl,mid,jacket} + Es_{mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 200000.00$

$$1 = A_{sl,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.10623177$$

$$2 = A_{sl,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.05957415$$

$$v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / fc) = 0.03374111$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 34.07073$$

$$cc (5A.5, TBDY) = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = A_{sl,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.13125889$$

$$2 = A_{sl,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.0736092$$

$$v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / fc) = 0.04169017$$

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

--->

$$su (4.8) = 0.1403202$$

$$\mu = MR_c (4.15) = 7.4472E+008$$

$$u = su (4.1) = 5.9367084E-005$$

Calculation of ratio  $lb/ld$

Adequate Lap Length:  $lb/ld \geq 1$

-----  
-----  
Calculation of Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 558200.119$   
-----

Calculation of Shear Strength at edge 1,  $V_{r1} = 558200.119$   
 $V_{r1} = V_n$  ((22.5.1.1), ACI 318-14)

-----  
NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f\*Vf'  
where Vf is the contribution of FRPs (11.3), ACI 440).

-----  
From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot \text{Area}_{jacket} + f'_{c\_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$ , but  $f_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)  
 $p_w = A_s / (b_w \cdot d) = 0.00331157$   
As (tension reinf.) = 709.9999  
bw = 400.00  
d = 536.00  
 $V_u \cdot d / \mu < 1 = 1.00$   
 $\mu = 1.0197E+006$   
Vu = 9840.633  
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 349068.643$   
 $V_{s1} = 311834.654$  is calculated for jacket, with:  
d = 536.00  
Av = 157079.633  
fy = 555.56  
s = 150.00  
Vs1 has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 37233.989$  is calculated for jacket, with:  
d2 = 400.00  
Av = 100530.965  
fy = 555.56  
s = 300.00  
Vs2 has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)  
 $2(1-s/d) = 0.50$   
Vf ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$   
-----

Calculation of Shear Strength at edge 2,  $V_{r2} = 558200.119$   
 $V_{r2} = V_n$  ((22.5.1.1), ACI 318-14)

-----  
NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f\*Vf'  
where Vf is the contribution of FRPs (11.3), ACI 440).

-----  
From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot \text{Area}_{jacket} + f'_{c\_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$ , but  $f_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)  
 $p_w = A_s / (b_w \cdot d) = 0.00331157$   
As (tension reinf.) = 709.9999  
bw = 400.00  
d = 536.00  
 $V_u \cdot d / \mu < 1 = 1.00$   
 $\mu = 1.0197E+006$   
Vu = 9840.633  
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 349068.643$   
 $V_{s1} = 311834.654$  is calculated for jacket, with:  
d = 536.00  
Av = 157079.633  
fy = 555.56  
s = 150.00  
Vs1 has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 37233.989$  is calculated for jacket, with:  
d = 400.00  
Av = 100530.965  
fy = 555.56  
-----

s = 300.00

Vs2 has been multiplied by 2(1-s/d) (s>d/2, according to ASCE 41-17,10.3.4)

2(1-s/d) = 0.50

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: Vs + Vf <= 818179.336

-----  
End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 3

-----  
Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

-----  
Knowledge Factor, = 1.00

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Primary Member: Concrete Strength, fc = fcm = 33.00

New material of Primary Member: Steel Strength, fs = fsm = 555.56

Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00

Existing Column

New material of Primary Member: Concrete Strength, fc = fcm = 33.00

New material of Primary Member: Steel Strength, fs = fsm = 555.56

Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, fs = 1.25\*fsm = 694.45

Existing Column

New material: Steel Strength, fs = 1.25\*fsm = 694.45

#####

External Height, H = 670.00

External Width, W = 400.00

Internal Height, H = 500.00

Internal Width, W = 200.00

Cover Thickness, c = 25.00

Mean Confinement Factor overall section = 1.03245

Element Length, L = 3000.00

Primary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length (lo/lo, min >= 1)

No FRP Wrapping

-----  
Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, Va = -6.9721474E-015

EDGE -B-

Shear Force, Vb = 6.9721474E-015

BOTH EDGES

Axial Force, F = -2237.255

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: Aslt = 709.9999

-Compression: Asl,c = 1668.186  
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension: Asl,t = 911.0619  
-Compression: Asl,c = 911.0619  
-Middle: Asl,m = 556.0619

-----  
-----  
Calculation of Shear Capacity ratio ,  $V_e/V_r = 0.53480887$   
Member Controlled by Flexure ( $V_e/V_r < 1$ )  
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 204955.561$   
with

$M_{pr1} = \text{Max}(\mu_{1+}, \mu_{1-}) = 3.0743E+008$   
 $\mu_{1+} = 3.0743E+008$ , 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  
 $\mu_{1-} = 3.0743E+008$ , 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  
 $M_{pr2} = \text{Max}(\mu_{2+}, \mu_{2-}) = 3.0743E+008$   
 $\mu_{2+} = 3.0743E+008$ , 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  
 $\mu_{2-} = 3.0743E+008$ , 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  
 $V_1 = -6.9721474E-015$ , is the shear force acting at edge 1 for the the static loading combination  
 $V_2 = 6.9721474E-015$ , is the shear force acting at edge 2 for the the static loading combination

-----  
Calculation of  $\mu_{1+}$   
-----

-----  
Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:  
 $\phi_u = 0.00010406$   
 $\mu = 3.0743E+008$

-----  
with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $\phi_c$  (5A.5, TBDY) = 0.002  
Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00650345$   
The Shear\_factor is considered equal to 1 (pure moment strength)  
From (5.4b), TBDY:  $\phi_u = 0.00650345$   
 $\phi_w$  (5.4c) = 0.00563796  
 $\phi_{ase}$  ((5.4d), TBDY) =  $(\phi_{ase1} \cdot A_{ext} + \phi_{ase2} \cdot A_{int})/A_{sec} = 0.14776895$   
 $\phi_{ase1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $\phi_{ase2} = \text{Max}(\phi_{ase1}, \phi_{ase2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $\phi_{psh,min} \cdot F_{ywe} = \text{Min}(\phi_{psh,x} \cdot F_{ywe}, \phi_{psh,y} \cdot F_{ywe}) = 1.25908$

-----  
 $\phi_{psh,x} \cdot F_{ywe} = \phi_{psh1} \cdot F_{ywe1} + \phi_{psh2} \cdot F_{ywe2} = 2.25223$   
 $\phi_{ps1}$  (external) =  $(A_{sh1} \cdot h_1/s_1)/A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} \cdot n_{s\_1} = 157.0796$   
No stirups,  $n_{s\_1} = 2.00$   
 $h_1 = 670.00$   
 $\phi_{ps2}$  (internal) =  $(A_{sh2} \cdot h_2/s_2)/A_{sec} = 0.00062519$

Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00156298  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 400.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00025008  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00232446

c = confinement factor = 1.03245

y1 = 0.0025

sh1 = 0.008

ft1 = 833.34

fy1 = 694.45

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 = 694.45

with Es1 = (Es,jacket\*Asl,ten,jacket + Es,core\*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025

sh2 = 0.008

ft2 = 833.34

fy2 = 694.45

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 = 694.45

with Es2 = (Es,jacket\*Asl,com,jacket + Es,core\*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 833.34

fyv = 694.45

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  $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 694.45$

with  $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.08015524$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.08015524$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.04892233$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

$f_{cc} (5A.2, TBDY) = 34.07073$

$cc (5A.5, TBDY) = 0.00232446$

$c = \text{confinement factor} = 1.03245$

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.09611636$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.09611636$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.05866412$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

$v < v_{s,c}$  - RHS eq.(4.5) is satisfied

---->

$su (4.9) = 0.13857861$

$Mu = MRc (4.14) = 3.0743E+008$

$u = su (4.1) = 0.00010406$

-----  
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:

$u = 0.00010406$

$Mu = 3.0743E+008$

-----  
with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$f_c = 33.00$

$co (5A.5, TBDY) = 0.002$

Final value of  $cu$ :  $cu^* = \text{shear\_factor} \cdot \text{Max}(cu, cc) = 0.00650345$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $cu = 0.00650345$

$w_e (5.4c) = 0.00563796$

$ase ((5.4d), TBDY) = (ase_1 \cdot A_{ext} + ase_2 \cdot A_{int}) / A_{sec} = 0.14776895$

$ase_1 = 0.14776895$

$bo_1 = 340.00$

$ho_1 = 610.00$

$bi_2_1 = 975400.00$

$ase_2 = \text{Max}(ase_1, ase_2) = 0.14776895$

$bo_2 = 192.00$

$ho_2 = 492.00$

$bi_2_2 = 557856.00$

$psh, \text{min} \cdot F_{ywe} = \text{Min}(psh, x \cdot F_{ywe}, psh, y \cdot F_{ywe}) = 1.25908$

-----  
 $psh, x \cdot F_{ywe} = psh_1 \cdot F_{ywe1} + ps_2 \cdot F_{ywe2} = 2.25223$

$ps_1 (\text{external}) = (Ash_1 \cdot h_1 / s_1) / A_{sec} = 0.00261799$

$Ash_1 = Astir_1 \cdot ns_1 = 157.0796$

No stirups,  $ns_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00062519$   
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$   
No stirups,  $ns_2 = 2.00$   
 $h2 = 500.00$

-----  
 $psh_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.25908$   
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$   
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$   
No stirups,  $ns_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$   
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$   
No stirups,  $ns_2 = 2.00$   
 $h2 = 200.00$

-----  
 $Asec = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fywe1 = 694.45$   
 $fywe2 = 694.45$   
 $fce = 33.00$

From ((5.A.5), TBDY), TBDY:  $cc = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$

$y1 = 0.0025$   
 $sh1 = 0.008$   
 $ft1 = 833.34$   
 $fy1 = 694.45$   
 $su1 = 0.032$

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

$lo/lou, \text{min} = lb/ld = 1.00$

$su1 = 0.4 \cdot esu1_{\text{nominal}} \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY:  $esu1_{\text{nominal}} = 0.08$ ,

For calculation of  $esu1_{\text{nominal}}$  and  $y1, sh1, ft1, fy1$ , it is considered  
characteristic value  $fsy1 = fs1 / 1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs1 = (fs_{\text{jacket}} \cdot Asl, \text{ten, jacket} + fs_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 694.45$

with  $Es1 = (Es_{\text{jacket}} \cdot Asl, \text{ten, jacket} + Es_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$

$y2 = 0.0025$   
 $sh2 = 0.008$   
 $ft2 = 833.34$   
 $fy2 = 694.45$   
 $su2 = 0.032$

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

$lo/lou, \text{min} = lb/lb, \text{min} = 1.00$

$su2 = 0.4 \cdot esu2_{\text{nominal}} \text{ ((5.5), TBDY)} = 0.032$

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.

$y2, sh2, ft2, fy2$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs2 = (fs_{\text{jacket}} \cdot Asl, \text{com, jacket} + fs_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 694.45$

with  $Es2 = (Es_{\text{jacket}} \cdot Asl, \text{com, jacket} + Es_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 200000.00$

$yv = 0.0025$   
 $shv = 0.008$   
 $ftv = 833.34$   
 $fyv = 694.45$   
 $suv = 0.032$

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

$lo/lou, \text{min} = lb/ld = 1.00$

$suv = 0.4 \cdot esuv_{\text{nominal}} \text{ ((5.5), TBDY)} = 0.032$

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  $f_{sv} = (f_{s,jacket} \cdot A_{s,l,mid,jacket} + f_{s,mid} \cdot A_{s,l,mid,core}) / A_{s,l,mid} = 694.45$

with  $E_{sv} = (E_{s,jacket} \cdot A_{s,l,mid,jacket} + E_{s,mid} \cdot A_{s,l,mid,core}) / A_{s,l,mid} = 200000.00$

1 =  $A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.08015524$

2 =  $A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.08015524$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.04892233$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

$f_{cc}$  (5A.2, TBDY) = 34.07073

$cc$  (5A.5, TBDY) = 0.00232446

$c$  = confinement factor = 1.03245

1 =  $A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.09611636$

2 =  $A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.09611636$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.05866412$

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) = 0.13857861

$Mu = MR_c$  (4.14) = 3.0743E+008

$u = su$  (4.1) = 0.00010406

-----  
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:

$u = 0.00010406$

$Mu = 3.0743E+008$

-----  
with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$f_c = 33.00$

$co$  (5A.5, TBDY) = 0.002

Final value of  $cu$ :  $cu^* = \text{shear\_factor} \cdot \text{Max}(cu, cc) = 0.00650345$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $cu = 0.00650345$

$w_e$  (5.4c) = 0.00563796

$ase$  ((5.4d), TBDY) =  $(ase_1 \cdot A_{ext} + ase_2 \cdot A_{int}) / A_{sec} = 0.14776895$

$ase_1 = 0.14776895$

$bo_1 = 340.00$

$ho_1 = 610.00$

$bi_{2,1} = 975400.00$

$ase_2 = \text{Max}(ase_1, ase_2) = 0.14776895$

$bo_2 = 192.00$

$ho_2 = 492.00$

$bi_{2,2} = 557856.00$

$psh_{,min} \cdot F_{ywe} = \text{Min}(psh_x \cdot F_{ywe}, psh_y \cdot F_{ywe}) = 1.25908$

psh\_x\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 2.25223  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00261799  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 670.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00062519  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00156298  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirups, ns\_1 = 2.00  
h1 = 400.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00025008  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirups, ns\_2 = 2.00  
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00232446

c = confinement factor = 1.03245

y1 = 0.0025

sh1 = 0.008

ft1 = 833.34

fy1 = 694.45

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  $\text{Min}(1, 1.25 * (\text{lb}/\text{ld})^{2/3})$ , from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket\*Asl,ten,jacket + fs,core\*Asl,ten,core)/Asl,ten = 694.45

with Es1 = (Es,jacket\*Asl,ten,jacket + Es,core\*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025

sh2 = 0.008

ft2 = 833.34

fy2 = 694.45

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  $\text{Min}(1, 1.25 * (\text{lb}/\text{ld})^{2/3})$ , from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket\*Asl,com,jacket + fs,core\*Asl,com,core)/Asl,com = 694.45

with Es2 = (Es,jacket\*Asl,com,jacket + Es,core\*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 833.34

fyv = 694.45

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

su = 0.4\*esuv\_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv\_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv\_nominal and yv, shv,ftv,fyv, it is considered characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25\*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.

with fsv = (fsjacket\*Asl,mid,jacket + fs,mid\*Asl,mid,core)/Asl,mid = 694.45

with Esv = (Es,jacket\*Asl,mid,jacket + Es,mid\*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.08015524

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.08015524

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.04892233

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07073

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.09611636

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.09611636

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.05866412

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) = 0.13857861

Mu = MRc (4.14) = 3.0743E+008

u = su (4.1) = 0.00010406

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu2-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 0.00010406

Mu = 3.0743E+008

with full section properties:

b = 670.00

d = 357.00

d' = 43.00

v = 0.00028344

N = 2237.255

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu: cu\* = shear\_factor \* Max( cu, cc) = 0.00650345

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.00650345

we (5.4c) = 0.00563796

ase ((5.4d), TBDY) = (ase1\*Aext+ase2\*Aint)/Asec = 0.14776895

ase1 = 0.14776895

bo\_1 = 340.00

ho\_1 = 610.00

bi2\_1 = 975400.00

ase2 = Max(ase1,ase2) = 0.14776895

bo\_2 = 192.00

ho\_2 = 492.00

$$bi2\_2 = 557856.00$$
$$psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.25908$$

$$psh\_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.25223$$
$$ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00261799$$
$$Ash1 = Astir\_1*ns\_1 = 157.0796$$
$$\text{No stirups, } ns\_1 = 2.00$$
$$h1 = 670.00$$
$$ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00062519$$
$$Ash2 = Astir\_2*ns\_2 = 100.531$$
$$\text{No stirups, } ns\_2 = 2.00$$
$$h2 = 500.00$$

$$psh\_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.25908$$
$$ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00156298$$
$$Ash1 = Astir\_1*ns\_1 = 157.0796$$
$$\text{No stirups, } ns\_1 = 2.00$$
$$h1 = 400.00$$
$$ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00025008$$
$$Ash2 = Astir\_2*ns\_2 = 100.531$$
$$\text{No stirups, } ns\_2 = 2.00$$
$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 694.45$$

$$fce = 33.00$$

$$\text{From } ((5.A.5), \text{ TBDY}), \text{ TBDY: } cc = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 833.34$$

$$fy1 = 694.45$$

$$su1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor and also multiplied by the shear\_factor according to 15.7.1.4, with Shear\_factor = 1.00

$$lo/lou,min = lb/l_d = 1.00$$

$$su1 = 0.4*esu1\_nominal \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu1\_nominal = 0.08,$$

For calculation of esu1\_nominal and y1, sh1, ft1, fy1, it is considered characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25*(lb/l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45$$

$$\text{with } Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 833.34$$

$$fy2 = 694.45$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor and also multiplied by the shear\_factor according to 15.7.1.4, with Shear\_factor = 1.00

$$lo/lou,min = lb/l_b,min = 1.00$$

$$su2 = 0.4*esu2\_nominal \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu2\_nominal = 0.08,$$

For calculation of esu2\_nominal and y2, sh2, ft2, fy2, it is considered characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25*(lb/l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45$$

$$\text{with } Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 833.34$$

$$fyv = 694.45$$

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 = (fsjacket\*Asl,mid,jacket + fs,mid\*Asl,mid,core)/Asl,mid = 694.45

with Esv = (Es,jacket\*Asl,mid,jacket + Es,mid\*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.08015524

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.08015524

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.04892233

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07073

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.09611636

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.09611636

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.05866412

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) = 0.13857861

Mu = MRc (4.14) = 3.0743E+008

u = su (4.1) = 0.00010406

-----  
Calculation of ratio lb/d

-----  
Adequate Lap Length: lb/d >= 1  
-----  
-----

-----  
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 383231.42  
-----

-----  
Calculation of Shear Strength at edge 1, Vr1 = 383231.42

Vr1 = Vn ((22.5.1.1), ACI 318-14)

-----  
NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f\*Vf'  
where Vf is the contribution of FRPs (11.3), ACI 440).

-----  
From Table (22.5.5.1), ACI 318-14: Vc = 197061.477

= 1 (normal-weight concrete)

Mean concrete strength: fc' = (fc'\_jacket\*Area\_jacket + fc'\_core\*Area\_core)/Area\_section = 33.00, but  $fc'^{0.5} \leq 8.3$   
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 = 8.6547052E-012

Vu = 6.9721474E-015

From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 186169.943

Vs1 = 186169.943 is calculated for jacket, with:

d = 320.00

Av = 157079.633

fy = 555.56

s = 150.00

Vs1 has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

Vs2 = 0.00 is calculated for jacket, with:

d2 = 160.00

Av = 100530.965

fy = 555.56

s = 300.00

Vs2 is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

-----  
Calculation of Shear Strength at edge 2, Vr2 = 383231.42

Vr2 = Vn ((22.5.1.1), ACI 318-14)

-----  
NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f\*Vf'  
where Vf is the contribution of FRPs (11.3), ACI 440).

-----  
From Table (22.5.5.1), ACI 318-14: Vc = 197061.477

= 1 (normal-weight concrete)

Mean concrete strength:  $f'_c = (f'_{c\_jacket} * Area\_jacket + f'_{c\_core} * Area\_core) / Area\_section = 33.00$ , but  $f'_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)

$\rho_w = A_s / (b_w * d) = 0.00331157$

As (tension reinf.) = 709.9999

bw = 670.00

d = 320.00

$V_u * d / M_u < 1 = 0.00$

Mu = 1.2266780E-011

Vu = 6.9721474E-015

From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 186169.943

Vs1 = 186169.943 is calculated for jacket, with:

d = 320.00

Av = 157079.633

fy = 555.56

s = 150.00

Vs1 has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

Vs2 = 0.00 is calculated for jacket, with:

d = 160.00

Av = 100530.965

fy = 555.56

s = 300.00

Vs2 is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

-----  
End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

-----  
Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)

Section Type: rcjars

Constant Properties

-----  
Knowledge Factor, = 1.00

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$   
New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$   
Concrete Elasticity,  $E_c = 26999.444$   
Steel Elasticity,  $E_s = 200000.00$   
External Height,  $H = 670.00$   
External Width,  $W = 400.00$   
Internal Height,  $H = 500.00$   
Internal Width,  $W = 200.00$   
Cover Thickness,  $c = 25.00$   
Element Length,  $L = 3000.00$   
Primary Member  
Smooth Bars  
Ductile Steel  
With Detailing for Earthquake Resistance (including stirrups closed at  $135^\circ$ )  
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,  $M = -6.5336195E-011$   
Shear Force,  $V_2 = 5.6924552E-014$   
Shear Force,  $V_3 = 15660.977$   
Axial Force,  $F = -3615.233$   
Longitudinal Reinforcement Area Distribution (in 2 divisions)  
-Tension:  $A_{st} = 709.9999$   
-Compression:  $A_{sc} = 1668.186$   
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $A_{st,ten} = 911.0619$   
-Compression:  $A_{sc,com} = 911.0619$   
-Middle:  $A_{sc,mid} = 556.0619$   
Longitudinal External Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $A_{st,ten,jacket} = 603.1858$   
-Compression:  $A_{sc,com,jacket} = 603.1858$   
-Middle:  $A_{sc,mid,jacket} = 402.1239$   
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $A_{st,ten,core} = 307.8761$   
-Compression:  $A_{sc,com,core} = 307.8761$   
-Middle:  $A_{sc,mid,core} = 153.938$   
Mean Diameter of Tension Reinforcement,  $DbL = 15.20$

-----  
New component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u_{,R} = 1.0^*$   $u = 0.03344037$   
 $u = y + p = 0.03344037$

-----  
- Calculation of  $y$  -

-----  
 $y = (M_y * L_s / 3) / E_{eff} = 0.00344037$  ((4.29), Biskinis Phd))  
 $M_y = 1.9915E+008$   
 $L_s = M/V$  (with  $L_s > 0.1 * L$  and  $L_s < 2 * L$ ) =  $1500.00$   
From table 10.5, ASCE 41\_17:  $E_{eff} = 0.3 * E_c * I_g = 2.8943E+013$

-----  
Calculation of Yielding Moment  $M_y$

-----  
Calculation of  $y$  and  $M_y$  according to Annex 7 -

-----  
 $y = \text{Min}(y_{ten}, y_{com})$   
 $y_{ten} = 1.0019693E-005$   
with  $f_y = 555.56$   
 $d = 357.00$   
 $y = 0.22343403$

A = 0.00996987  
B = 0.00559733  
with pt = 0.00380895  
pc = 0.00380895  
pv = 0.00232477  
N = 3615.233  
b = 670.00  
" = 0.12044818  
y\_comp = 2.7622785E-005  
with fc = 33.00  
Ec = 26999.444  
y = 0.22309813  
A = 0.00990831  
B = 0.00557012  
with Es = 200000.00

-----  
Calculation of ratio lb/d

-----  
Adequate Lap Length: lb/d >= 1

-----  
- Calculation of p -

-----  
From table 10-7: p = 0.03

with:

- Condition i occurred

Beam controlled by flexure:  $V_p/V_o \leq 1$

shear control ratio  $V_p/V_o = 0.53480887$

- Transverse Reinforcement: NC

- Stirrup Spacing > d/3

- Low ductility demand,  $\lambda < 2$  (table 10-6, ASCE 41-17)

= 1.7139944E-022

- Stirrup Spacing <= d/2

d = d\_external = 357.00

s = s\_external = 150.00

- Strength provided by hoops  $V_s < 3/4$ \*design Shear

$V_s = 215957.134$ , already given in calculation of shear control ratio

design Shear = 5.6924552E-014

- ( - ')/ bal = -0.23508921

=  $A_{st}/(b_w*d) = 0.00296835$

Tension Reinf Area:  $A_{st} = 709.9999$

' =  $A_{sc}/(b_w*d) = 0.00697431$

Compression Reinf Area:  $A_{sc} = 1668.186$

From (B-1), ACI 318-11: bal = 0.01704017

$f_c = (f_{c\_jacket}*Area\_jacket + f_{c\_core}*Area\_core)/section\_area = 33.00$

$f_y = f_{y\_jacket\_bars} = 555.56$

From 10.2.7.3, ACI 318-11:  $\lambda = 0.65$

From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + \lambda) = 0.51922877$

$\lambda = 0.0027778$

-  $V/(b_w*d*f_c^{0.5}) = 4.9891075E-019$ , NOTE: units in lb & in

$b_w = 670.00$

-----  
End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)