

# Detailed Member Calculations

**Units: N&mm**

**Regulation: ASCE 41-17**

## Calculation No. 1

beam B1, Floor 1

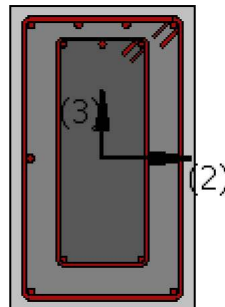
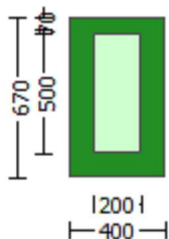
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

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  $135^\circ$ )  
 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,  $M_a = -1.5808831E-010$   
 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:  $A_{st,com} = 911.0619$   
 -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  $V_R = 1.0 \cdot V_n = 339071.608$   
 $V_n ((22.5.1.1), \text{ACI } 318-14) = 339071.608$

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:  $f'_c = (f'_{c\_jacket} \cdot \text{Area}_{jacket} + f'_{c\_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 25.00$ , but  $f'_c^{0.5} \leq 8.3$   
 MPa (22.5.3.1, ACI 318-14)  
 $p_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 1.5808831E-010$   
 $V_u = 8.4049242E-014$   
 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

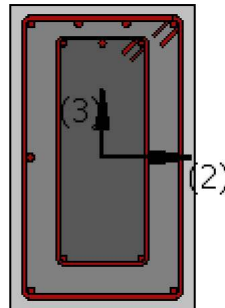
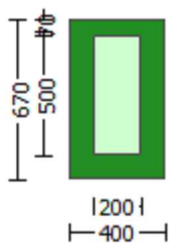
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (  $\phi$  )

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,  $\phi = 1.00$

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:  $A_{sl,t} = 709.9999$   
-Compression:  $A_{sl,c} = 1668.186$   
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $A_{sl,ten} = 709.9999$   
-Compression:  $A_{sl,com} = 1266.062$   
-Middle:  $A_{sl,mid} = 402.1239$

Calculation of Shear Capacity ratio,  $V_e/V_r = 0.90705729$   
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  
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 7.4472E+008$   
 $\mu_{u1+} = 4.3734E+008$ , 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  
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 7.4472E+008$   
 $\mu_{u2+} = 4.3734E+008$ , 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

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

---

#### Calculation of Mu1+

---

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

$$u = 5.6088283E-005$$

$$Mu = 4.3734E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

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

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

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

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

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

$$ase1 = 0.14776895$$

$$bo\_1 = 340.00$$

$$ho\_1 = 610.00$$

$$bi2\_1 = 975400.00$$

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

$$bo\_2 = 192.00$$

$$ho\_2 = 492.00$$

$$bi2\_2 = 557856.00$$

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

---

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

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

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

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

$$h1 = 670.00$$

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

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

$$\text{No stirups, } ns\_2 = 2.00$$

$$h2 = 500.00$$

---

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

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

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

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

$$h1 = 400.00$$

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

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

$$\text{No stirups, } ns\_2 = 2.00$$

$$h2 = 200.00$$

---

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 833.34$$

$$fy1 = 694.45$$

```

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/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 fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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:

$\mu = 5.9367084E-005$

$\mu_u = 7.4472E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.00027032$

$N = 2237.255$

$f_c = 33.00$

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

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)

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

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

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

$\alpha_{se1} = 0.14776895$

$b_{o1} = 340.00$

$h_{o1} = 610.00$

$b_{i21} = 975400.00$

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

$b_{o2} = 192.00$

$h_{o2} = 492.00$

$b_{i22} = 557856.00$

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

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

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

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

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

$h_1 = 670.00$

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

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

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

$h_2 = 500.00$

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

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

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

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

$h_1 = 400.00$

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

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

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

$h_2 = 200.00$

$A_{sec} = 268000.00$

$s_1 = 150.00$

$s_2 = 300.00$

$f_{ywe1} = 694.45$

$f_{ywe2} = 694.45$

$f_{ce} = 33.00$

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

$\mu_c$  = 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/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 fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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  $lb/ld$

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

Calculation of  $Mu_{2+}$

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

$$u = 5.6088283E-005$$

$$Mu = 4.3734E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$fc = 33.00$$

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

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

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

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

$$we(5.4c) = 0.00563796$$

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

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

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

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

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

$$psh_x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 2.25223$$

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

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

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

$$h1 = 670.00$$

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

$$Ash2 = Astir_2 * ns_2 = 100.531$$

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

$$h2 = 500.00$$

$$psh_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.25908$$

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

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

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

$$h1 = 400.00$$

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

$$Ash2 = Astir_2 * ns_2 = 100.531$$

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

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

```

fywe2 = 694.45
fce = 33.00
From ((5A.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
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 Min(1,1.25*(lb/lb,min)^ 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: Unconfinedsd full section - Steel rupture

```

satisfies Eq. (4.3)

--->

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

--->

$\mu_u (4.9) = 0.09006517$

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

$u = \mu_u (4.1) = 5.6088283E-005$

Calculation of ratio  $I_b/I_d$

Adequate Lap Length:  $I_b/I_d \geq 1$

Calculation of  $\mu_{u2}$ -

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

$\mu_u = 5.9367084E-005$

$M_u = 7.4472E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.00027032$

$N = 2237.255$

$f_c = 33.00$

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

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)

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

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

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

$a_{se1} = 0.14776895$

$b_{o,1} = 340.00$

$h_{o,1} = 610.00$

$b_{i2,1} = 975400.00$

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

$b_{o,2} = 192.00$

$h_{o,2} = 492.00$

$b_{i2,2} = 557856.00$

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

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

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

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

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

$h_1 = 670.00$

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

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

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

$h_2 = 500.00$

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

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

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

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

$h_1 = 400.00$

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

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

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

$h_2 = 200.00$

$A_{sec} = 268000.00$

$s1 = 150.00$   
 $s2 = 300.00$   
 $fy_{we1} = 694.45$   
 $fy_{we2} = 694.45$   
 $f_{ce} = 33.00$   
 From ((5.A.5), TBDY), TBDY:  $cc = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $y1 = 0.0025$   
 $sh1 = 0.008$   
 $ft1 = 833.34$   
 $fy1 = 694.45$   
 $su1 = 0.032$   
 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  $fs1 = (fs_{jacket} * Asl, \text{ten}, \text{jacket} + fs_{core} * Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 694.45$   
 with  $Es1 = (Es_{jacket} * Asl, \text{ten}, \text{jacket} + Es_{core} * Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 200000.00$   
 $y2 = 0.0025$   
 $sh2 = 0.008$   
 $ft2 = 833.34$   
 $fy2 = 694.45$   
 $su2 = 0.032$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou, \min = lb/lb, \min = 1.00$   
 $su2 = 0.4 * esu2\_nominal ((5.5), TBDY) = 0.032$   
 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.  
 with  $fs2 = (fs_{jacket} * Asl, \text{com}, \text{jacket} + fs_{core} * Asl, \text{com}, \text{core}) / Asl, \text{com} = 694.45$   
 with  $Es2 = (Es_{jacket} * Asl, \text{com}, \text{jacket} + Es_{core} * Asl, \text{com}, \text{core}) / Asl, \text{com} = 200000.00$   
 $yv = 0.0025$   
 $shv = 0.008$   
 $ftv = 833.34$   
 $fyv = 694.45$   
 $suv = 0.032$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou, \min = lb/ld = 1.00$   
 $suv = 0.4 * esuv\_nominal ((5.5), TBDY) = 0.032$   
 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.  
 with  $fsv = (fs_{jacket} * Asl, \text{mid}, \text{jacket} + fs_{mid} * Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 694.45$   
 with  $Es_v = (Es_{jacket} * Asl, \text{mid}, \text{jacket} + Es_{mid} * Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 200000.00$   
 $1 = Asl, \text{ten} / (b * d) * (fs1 / f_c) = 0.10623177$   
 $2 = Asl, \text{com} / (b * d) * (fs2 / f_c) = 0.05957415$   
 $v = Asl, \text{mid} / (b * d) * (fsv / f_c) = 0.03374111$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = Asl, \text{ten} / (b * d) * (fs1 / f_c) = 0.13125889$

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

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

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

---->

$$s_u(4.8) = 0.1403202$$

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

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

Calculation of ratio  $l_b/l_d$

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

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

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

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

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

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)

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

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

$$b_w = 400.00$$

$$d = 536.00$$

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

$$M_u = 1.0197E+006$$

$$V_u = 9840.633$$

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)

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

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

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

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) ' $V_w$ ' 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 =  $A_s/(b_w*d) = 0.00331157$   
As (tension reinf.) = 709.9999  
bw = 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 = 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 ( $l_o/l_{ou}, \min \geq 1$ )  
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:  $As_{mid} = 556.0619$

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  
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 3.0743E+008$   
 $\mu_{u1+} = 3.0743E+008$ , 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  
 $\mu_{u1-} = 3.0743E+008$ , 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  
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 3.0743E+008$   
 $\mu_{u2+} = 3.0743E+008$ , 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  
 $\mu_{u2-} = 3.0743E+008$ , 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 $\mu_{u1+}$

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

with full section properties:

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

$w_e (5.4c) = 0.00563796$   
 $ase ((5.4d), TBDY) = (ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo\_1 = 340.00$   
 $ho\_1 = 610.00$   
 $bi2\_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$   
 $psh, \min \cdot F_{ywe} = \text{Min}(psh, x \cdot F_{ywe}, psh, y \cdot F_{ywe}) = 1.25908$

$psh, x \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 2.25223$   
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.00261799$   
 $Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$   
 $\text{No stirups, } ns\_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00062519$   
 $Ash2 = Astir\_2 \cdot ns\_2 = 100.531$   
 $\text{No stirups, } ns\_2 = 2.00$   
 $h2 = 500.00$

$psh, y \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 1.25908$   
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.00156298$   
 $Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$   
 $\text{No stirups, } ns\_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00025008$   
 $Ash2 = Astir\_2 \cdot ns\_2 = 100.531$   
 $\text{No stirups, } ns\_2 = 2.00$   
 $h2 = 200.00$

$A_{sec} = 268000.00$

$s1 = 150.00$

$s2 = 300.00$

$fywe1 = 694.45$

$fywe2 = 694.45$

$f_{ce} = 33.00$

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

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

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

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

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

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

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

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

$y2 = 0.0025$

$sh2 = 0.008$

$ft2 = 833.34$

$fy2 = 694.45$

$su2 = 0.032$

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

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

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

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



For calculation of  $es_{2\_nominal}$  and  $y_2$ ,  $sh_2$ ,  $ft_2$ ,  $fy_2$ , it is considered characteristic value  $fs_{y2} = fs_2/1.2$ , from table 5.1, TBDY.  
 $y_1$ ,  $sh_1$ ,  $ft_1$ ,  $fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 694.45$   
 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  
 $lo/lo_{u,min} = lb/ld = 1.00$

$suv = 0.4 \cdot es_{u\_nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY:  $es_{u\_nominal} = 0.08$ ,

considering characteristic value  $fs_{yv} = fs_v/1.2$ , from table 5.1, TBDY

For calculation of  $es_{u\_nominal}$  and  $y_v$ ,  $sh_v$ ,  $ft_v$ ,  $fy_v$ , it is considered characteristic value  $fs_{yv} = fs_v/1.2$ , from table 5.1, TBDY.

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

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

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

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

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

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

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

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

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

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

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

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

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

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

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

--->

$su (4.9) = 0.13857861$

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

$u = su (4.1) = 0.00010406$

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  $cu$ :  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00650345$   
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  
Shear\_factor = 1.00

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

$su1 = 0.4 * esu1\_nominal$  ((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

$l_o/l_{ou,min} = l_b/l_{b,min} = 1.00$   
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$   
 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  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_2 = (fs_{jacket} * Asl_{com,jacket} + fs_{core} * Asl_{com,core}) / Asl_{com} = 694.45$   
 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  
 $l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fsyv = fs_v/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fsyv = fs_v/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_v = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 694.45$   
 with  $Es_v = (Es_{jacket} * Asl_{mid,jacket} + Es_{mid} * Asl_{mid,core}) / Asl_{mid} = 200000.00$   
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.08015524$   
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.08015524$   
 $v = Asl_{mid} / (b * d) * (fs_v / fc) = 0.04892233$   
 and confined core properties:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.09611636$   
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.09611636$   
 $v = Asl_{mid} / (b * d) * (fs_v / fc) = 0.05866412$   
 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  $l_b/l_d$

-----

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:

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

$N = 2237.255$   
 $f_c = 33.00$   
 $\alpha (5A.5, TBDY) = 0.002$   
 Final value of  $\alpha$ :  $\alpha^* = \text{shear\_factor} * \text{Max}(\alpha, \alpha_c) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $\alpha = 0.00650345$   
 $w_e (5.4c) = 0.00563796$   
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$   
 $a_{se1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.25223$   
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 No stirrups,  $n_{s\_1} = 2.00$   
 $h_1 = 670.00$   
 $p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$   
 $A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$   
 No stirrups,  $n_{s\_2} = 2.00$   
 $h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.25908$   
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 No stirrups,  $n_{s\_1} = 2.00$   
 $h_1 = 400.00$   
 $p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$   
 $A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$   
 No stirrups,  $n_{s\_2} = 2.00$   
 $h_2 = 200.00$

$A_{sec} = 268000.00$   
 $s_1 = 150.00$   
 $s_2 = 300.00$   
 $f_{ywe1} = 694.45$   
 $f_{ywe2} = 694.45$   
 $f_{ce} = 33.00$

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

$y_1 = 0.0025$   
 $sh_1 = 0.008$   
 $ft_1 = 833.34$   
 $fy_1 = 694.45$   
 $su_1 = 0.032$

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

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

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

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

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

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

with  $fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 694.45$

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  
 $l_o/l_{ou,min} = l_b/l_{b,min} = 1.00$   
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$   
 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  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 694.45$   
 with  $Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$   
 $y_v = 0.0025$   
 $sh_v = 0.008$   
 $ft_v = 833.34$   
 $fy_v = 694.45$   
 $suv = 0.032$   
 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  
 $l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 694.45$   
 with  $Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$   
 $1 = A_{sl,ten} / (b * d) * (fs_1 / f_c) = 0.08015524$   
 $2 = A_{sl,com} / (b * d) * (fs_2 / f_c) = 0.08015524$   
 $v = A_{sl,mid} / (b * d) * (fsv / f_c) = 0.04892233$   
 and confined core properties:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = A_{sl,ten} / (b * d) * (fs_1 / f_c) = 0.09611636$   
 $2 = A_{sl,com} / (b * d) * (fs_2 / f_c) = 0.09611636$   
 $v = A_{sl,mid} / (b * d) * (fsv / f_c) = 0.05866412$   
 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:

$b = 670.00$

$d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $\phi_c (5A.5, \text{TB DY}) = 0.002$   
 Final value of  $\phi_c$ :  $\phi_c^* = \text{shear\_factor} * \text{Max}(\phi_c, \phi_c) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TB DY:  $\phi_c = 0.00650345$   
 $\phi_w (5.4c) = 0.00563796$   
 $\phi_{se} ((5.4d), \text{TB DY}) = (\phi_{se1} * A_{ext} + \phi_{se2} * A_{int}) / A_{sec} = 0.14776895$   
 $\phi_{se1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.25908$

$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.25223$   
 $\phi_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 No stirups,  $n_{s\_1} = 2.00$   
 $h_1 = 670.00$   
 $\phi_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$   
 $A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$   
 No stirups,  $n_{s\_2} = 2.00$   
 $h_2 = 500.00$

$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.25908$   
 $\phi_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 No stirups,  $n_{s\_1} = 2.00$   
 $h_1 = 400.00$   
 $\phi_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$   
 $A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$   
 No stirups,  $n_{s\_2} = 2.00$   
 $h_2 = 200.00$

$A_{sec} = 268000.00$   
 $s_1 = 150.00$   
 $s_2 = 300.00$

$f_{ywe1} = 694.45$   
 $f_{ywe2} = 694.45$   
 $f_{ce} = 33.00$

From ((5.A.5), TB DY), TB DY:  $\phi_c = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$

$y_1 = 0.0025$   
 $sh_1 = 0.008$   
 $ft_1 = 833.34$   
 $fy_1 = 694.45$   
 $su_1 = 0.032$

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

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

$su_1 = 0.4 * esu_1_{\text{nominal}} ((5.5), \text{TB DY}) = 0.032$

From table 5A.1, TB DY:  $esu_1_{\text{nominal}} = 0.08$ ,

For calculation of  $esu_1_{\text{nominal}}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered  
 characteristic value  $fs_1 = fs_1 / 1.2$ , from table 5.1, TB DY.

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

with  $fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 694.45$

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

$y_2 = 0.0025$   
 $sh_2 = 0.008$

```

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*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 Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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  $V_r = \text{Min}(V_{r1}, V_{r2}) = 383231.42$

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

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

= 1 (normal-weight concrete)

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

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

$A_s$  (tension reinf.) = 709.9999

$b_w = 670.00$

$d = 320.00$

$V_u \cdot d / M_u < 1 = 0.00$

$M_u = 8.6547052E-012$

$V_u = 6.9721474E-015$

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

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

$A_s$  (tension reinf.) = 709.9999

$b_w = 670.00$

$d = 320.00$

$V_u \cdot d / M_u < 1 = 0.00$

$M_u = 1.2266780E-011$

$V_u = 6.9721474E-015$

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:  $As_t = 709.9999$

-Compression:  $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

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

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

-Middle:  $As_{mid} = 402.1239$

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

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

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

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

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

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

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

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

Mean Diameter of Tension Reinforcement,  $Db_L = 15.00$

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

$u = \gamma + \rho = 0.01674201$

- Calculation of  $\gamma$  -

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

Calculation of Yielding Moment  $M_y$

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

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

Calculation of ratio  $I_b/I_d$

Adequate Lap Length:  $I_b/I_d \geq 1$

- Calculation of  $p$  -

From table 10-7:  $p = 0.01$

with:

- Condition i occurred

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

shear control ratio  $V_p/V_o = 0.90705729$

- Transverse Reinforcement: C

- Stirrup Spacing  $\leq d/3$

- Low ductility demand,  $\gamma / y < 2$  (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

-  $(\gamma - \gamma') / \gamma_{bal} = -0.22420649$

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

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

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

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

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

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

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

From 10.2.7.3, ACI 318-11:  $\gamma_1 = 0.65$

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

$$y = 0.0027778$$

-  $V/(bw*d*fc^{0.5}) = 0.00718664$ , 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

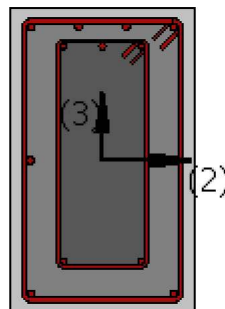
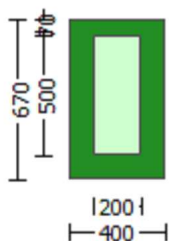
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

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,  $\gamma = 1.00$

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 ( $l_o/l_{ou,min} = l_b/d \geq 1$ )  
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:  $A_{st,com} = 1266.062$   
-Middle:  $A_{st,mid} = 402.1239$   
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)  
 $p_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / M_u < 1 = 0.04171521$   
 $M_u = 1.1047E+007$   
 $V_u = 859.7793$   
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)

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

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

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

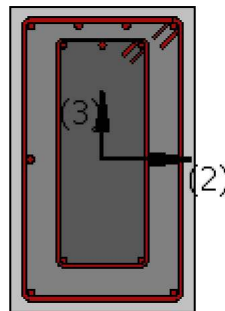
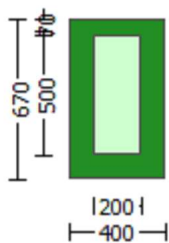
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (  $\phi$  )

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 ( $l_o/l_{ou,min} \geq 1$ )  
 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:  $A_{st,com} = 1266.062$   
   -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  
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 7.4472E+008$   
 $\mu_{u1+} = 4.3734E+008$ , 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  
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 7.4472E+008$   
 $\mu_{u2+} = 4.3734E+008$ , 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 Mu1+

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:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

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

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

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

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

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

$$a_{se1} = 0.14776895$$

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

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

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

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

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

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

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

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

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

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

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

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

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
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 = (fsjacket*Aslten,jacket + fscore*Aslten,core)/Aslten = 694.45
with Es1 = (Esjacket*Aslten,jacket + Escore*Aslten,core)/Aslten = 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 = (fsjacket*Aslcom,jacket + fscore*Aslcom,core)/Aslcom = 694.45
with Es2 = (Esjacket*Aslcom,jacket + Escore*Aslcom,core)/Aslcom = 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*esuvnominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuvnominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuvnominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)2/3), from 10.3.5, ASCE 41-17.
with fsv = (fsjacket*Aslmid,jacket + fsmid*Aslmid,core)/Aslmid = 694.45
with Esv = (Esjacket*Aslmid,jacket + Esmid*Aslmid,core)/Aslmid = 200000.00
1 = Aslten/(b*d)*(fs1/fc) = 0.05957415
2 = Aslcom/(b*d)*(fs2/fc) = 0.10623177
v = Aslmid/(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 = Aslten/(b*d)*(fs1/fc) = 0.0736092
2 = Aslcom/(b*d)*(fs2/fc) = 0.13125889
v = Aslmid/(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/l<sub>d</sub>



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

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:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

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

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

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

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

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

$$a_{se1} = 0.14776895$$

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

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

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

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

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

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

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

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

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

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

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

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$f_{t1} = 833.34$$

$$f_{y1} = 694.45$$

```

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 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,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 Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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  $\mu_{2+}$

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

$$u = 5.6088283E-005$$

$$\mu = 4.3734E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

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

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

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

$$\mu(5.4c) = 0.00563796$$

$$\alpha((5.4d), \text{TBDY}) = (\alpha_1 * A_{ext} + \alpha_2 * A_{int}) / A_{sec} = 0.14776895$$

$$\alpha_1 = 0.14776895$$

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

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

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

$$\alpha_2 = \text{Max}(\alpha_1, \alpha_2) = 0.14776895$$

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

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

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

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

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

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

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

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_c = 33.00$$

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

```

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 fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 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 Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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:  $lb/d \geq 1$

Calculation of  $Mu_2$ -

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

$$u = 5.9367084E-005$$

$$Mu = 7.4472E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$fc = 33.00$$

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

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

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

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

$$we(5.4c) = 0.00563796$$

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

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

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

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

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

$$psh\_x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 2.25223$$

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

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

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

$$h1 = 670.00$$

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

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

$$\text{No stirups, } ns\_2 = 2.00$$

$$h2 = 500.00$$

$$psh\_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.25908$$

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

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

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

$$h1 = 400.00$$

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

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

$$\text{No stirups, } ns\_2 = 2.00$$

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$fy_{we2} = 694.45$   
 $f_{ce} = 33.00$   
 From ((5A.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  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou, \min = lb/ld = 1.00$   
 $su1 = 0.4 * esu1\_nominal ((5.5), TBDY) = 0.032$   
 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  $fs1 = (fs_{jacket} * Asl, \text{ten}, \text{jacket} + fs_{core} * Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 694.45$   
 with  $Es1 = (Es_{jacket} * Asl, \text{ten}, \text{jacket} + Es_{core} * Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 200000.00$   
 $y2 = 0.0025$   
 $sh2 = 0.008$   
 $ft2 = 833.34$   
 $fy2 = 694.45$   
 $su2 = 0.032$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou, \min = lb/lb, \min = 1.00$   
 $su2 = 0.4 * esu2\_nominal ((5.5), TBDY) = 0.032$   
 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.  
 with  $fs2 = (fs_{jacket} * Asl, \text{com}, \text{jacket} + fs_{core} * Asl, \text{com}, \text{core}) / Asl, \text{com} = 694.45$   
 with  $Es2 = (Es_{jacket} * Asl, \text{com}, \text{jacket} + Es_{core} * Asl, \text{com}, \text{core}) / Asl, \text{com} = 200000.00$   
 $yv = 0.0025$   
 $shv = 0.008$   
 $ftv = 833.34$   
 $fyv = 694.45$   
 $suv = 0.032$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou, \min = lb/ld = 1.00$   
 $suv = 0.4 * esuv\_nominal ((5.5), TBDY) = 0.032$   
 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.  
 with  $fsv = (fs_{jacket} * Asl, \text{mid}, \text{jacket} + fs_{mid} * Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 694.45$   
 with  $Es_v = (Es_{jacket} * Asl, \text{mid}, \text{jacket} + Es_{mid} * Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 200000.00$   
 $1 = Asl, \text{ten} / (b * d) * (fs1 / fc) = 0.10623177$   
 $2 = Asl, \text{com} / (b * d) * (fs2 / fc) = 0.05957415$   
 $v = Asl, \text{mid} / (b * d) * (fsv / fc) = 0.03374111$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = Asl, \text{ten} / (b * d) * (fs1 / fc) = 0.13125889$   
 $2 = Asl, \text{com} / (b * d) * (fs2 / fc) = 0.0736092$   
 $v = Asl, \text{mid} / (b * d) * (fsv / fc) = 0.04169017$   
 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  
 $\mu_u = M_{Rc}$  (4.15) = 7.4472E+008  
 $u = \mu_u$  (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  $V_r = \min(V_{r1}, V_{r2}) = 558200.119$

Calculation of Shear Strength at edge 1,  $V_{r1} = 558200.119$   
 $V_{r1} = V_n$  ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
 = 1 (normal-weight concrete)  
 Mean concrete strength:  $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 33.00$ , but  $f'_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (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 ' $V_w + f^*V_f$ '  
 where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
 = 1 (normal-weight concrete)  
 Mean concrete strength:  $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 33.00$ , but  $f'_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 400.00$

$d = 536.00$   
 $V_u \cdot d / M_u < 1 = 1.00$   
 $M_u = 1.0197E+006$   
 $V_u = 9840.633$   
 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)  
 $2(1-s/d) = 0.50$   
 $V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$   
 From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

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

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

Constant Properties

-----  
 Knowledge Factor,  $\phi = 1.00$   
 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 ( $l_o/l_{ou}, \min \geq 1$ )  
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:  $As_{l,com} = 911.0619$   
-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  
 $M_{pr1} = \max(\mu_{1+}, \mu_{1-}) = 3.0743E+008$   
 $\mu_{1+} = 3.0743E+008$ , 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  
 $M_{pr2} = \max(\mu_{2+}, \mu_{2-}) = 3.0743E+008$   
 $\mu_{2+} = 3.0743E+008$ , is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the 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 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 static loading combination  
 $V_2 = 6.9721474E-015$ , is the shear force acting at edge 2 for the static loading combination

#### Calculation of $\mu_{1+}$

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

with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $\phi_c$  (5A.5, TBDY) = 0.002  
Final value of  $\phi_{cu}$ :  $\phi_{cu} = \text{shear\_factor} \cdot \max(\phi_{cu}, \phi_c) = 0.00650345$   
The Shear\_factor is considered equal to 1 (pure moment strength)  
From (5.4b), TBDY:  $\phi_{cu} = 0.00650345$   
 $\phi_{we}$  (5.4c) = 0.00563796  
 $\phi_{ase}$  ((5.4d), TBDY) =  $(\phi_{ase1} \cdot A_{ext} + \phi_{ase2} \cdot A_{int}) / A_{sec} = 0.14776895$   
 $\phi_{ase1} = 0.14776895$

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

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

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

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

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

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

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

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

$su1 = 0.4 * esu1\_nominal ((5.5), \text{ TBDY}) = 0.032$

$\text{From table 5A.1, TBDY: } esu1\_nominal = 0.08,$

For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered  
 characteristic value  $fsy1 = fs1 / 1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$ , 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  
 $\text{Shear\_factor} = 1.00$

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

$su2 = 0.4 * esu2\_nominal ((5.5), \text{ TBDY}) = 0.032$

$\text{From table 5A.1, TBDY: } esu2\_nominal = 0.08,$

For calculation of  $esu2\_nominal$  and  $y2, sh2, ft2, fy2$ , it is considered  
 characteristic value  $fsy2 = fs2 / 1.2$ , from table 5.1, TBDY.

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

```

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 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 Min(1,1.25*(lb/d)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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 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
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

```

$w_e (5.4c) = 0.00563796$   
 $ase ((5.4d), TBDY) = (ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo\_1 = 340.00$   
 $ho\_1 = 610.00$   
 $bi2\_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$   
 $psh, \min \cdot F_{ywe} = \text{Min}(psh, x \cdot F_{ywe}, psh, y \cdot F_{ywe}) = 1.25908$

$psh, x \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 2.25223$   
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.00261799$   
 $Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$   
 $\text{No stirups, } ns\_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00062519$   
 $Ash2 = Astir\_2 \cdot ns\_2 = 100.531$   
 $\text{No stirups, } ns\_2 = 2.00$   
 $h2 = 500.00$

$psh, y \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 1.25908$   
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.00156298$   
 $Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$   
 $\text{No stirups, } ns\_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00025008$   
 $Ash2 = Astir\_2 \cdot ns\_2 = 100.531$   
 $\text{No stirups, } ns\_2 = 2.00$   
 $h2 = 200.00$

$A_{sec} = 268000.00$

$s1 = 150.00$

$s2 = 300.00$

$f_{ywe1} = 694.45$

$f_{ywe2} = 694.45$

$f_{ce} = 33.00$

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

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

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

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

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

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

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

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

$y2 = 0.0025$

$sh2 = 0.008$

$ft2 = 833.34$

$fy2 = 694.45$

$su2 = 0.032$

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

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

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

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

For calculation of  $es_{u2\_nominal}$  and  $y_2$ ,  $sh_{2,ft2,fy2}$ , it is considered characteristic value  $fs_{y2} = fs_2/1.2$ , from table 5.1, TBDY.

$y_1$ ,  $sh_{1,ft1,fy1}$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.

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

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

$lo/lou_{min} = l_b/l_d = 1.00$   
 $suv = 0.4 \cdot es_{u\_nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY:  $es_{u\_nominal} = 0.08$ , considering characteristic value  $fs_v = fs_v/1.2$ , from table 5.1, TBDY

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

$y_1$ ,  $sh_{1,ft1,fy1}$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.

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

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

$1 = Asl_{ten}/(b \cdot d) \cdot (fs_1/f_c) = 0.08015524$   
 $2 = Asl_{com}/(b \cdot d) \cdot (fs_2/f_c) = 0.08015524$   
 $v = Asl_{mid}/(b \cdot d) \cdot (fs_v/f_c) = 0.04892233$

and confined core properties:

$b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = Asl_{ten}/(b \cdot d) \cdot (fs_1/f_c) = 0.09611636$   
 $2 = Asl_{com}/(b \cdot d) \cdot (fs_2/f_c) = 0.09611636$   
 $v = Asl_{mid}/(b \cdot d) \cdot (fs_v/f_c) = 0.05866412$

Case/Assumption: Unconfined full section - Steel rupture  
 ' does not satisfy Eq. (4.3)

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

$su (4.9) = 0.13857861$   
 $Mu = MR_c (4.14) = 3.0743E+008$   
 $u = su (4.1) = 0.00010406$

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  $cu$ :  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00650345$   
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\*Fywe =  $\text{Min}(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.25908$

psh\_x\*Fywe =  $psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25223$   
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\*Fywe =  $psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25908$   
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.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 =  $l_b / l_d = 1.00$

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  $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$ , 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

$l_o/l_{ou,min} = l_b/l_{b,min} = 1.00$   
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$   
 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  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_2 = (fs_{jacket} * Asl_{com,jacket} + fs_{core} * Asl_{com,core}) / Asl_{com} = 694.45$   
 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  
 $l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 694.45$   
 with  $Es_v = (Es_{jacket} * Asl_{mid,jacket} + Es_{mid} * Asl_{mid,core}) / Asl_{mid} = 200000.00$   
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.08015524$   
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.08015524$   
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.04892233$   
 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  
 ---->  
 $su (4.9) = 0.13857861$   
 $Mu = MRc (4.14) = 3.0743E+008$   
 $u = su (4.1) = 0.00010406$

-----

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:

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

$N = 2237.255$   
 $f_c = 33.00$   
 $\alpha (5A.5, TBDY) = 0.002$   
 Final value of  $\alpha$ :  $\alpha^* = \text{shear\_factor} * \text{Max}(\alpha, \alpha_c) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $\alpha_c = 0.00650345$   
 $w_e (5.4c) = 0.00563796$   
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$   
 $a_{se1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.25223$   
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 No stirrups,  $n_{s\_1} = 2.00$   
 $h_1 = 670.00$   
 $p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$   
 $A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$   
 No stirrups,  $n_{s\_2} = 2.00$   
 $h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.25908$   
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 No stirrups,  $n_{s\_1} = 2.00$   
 $h_1 = 400.00$   
 $p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$   
 $A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$   
 No stirrups,  $n_{s\_2} = 2.00$   
 $h_2 = 200.00$

$A_{sec} = 268000.00$   
 $s_1 = 150.00$   
 $s_2 = 300.00$   
 $f_{ywe1} = 694.45$   
 $f_{ywe2} = 694.45$   
 $f_{ce} = 33.00$

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

$y_1 = 0.0025$   
 $sh_1 = 0.008$   
 $ft_1 = 833.34$   
 $fy_1 = 694.45$   
 $su_1 = 0.032$

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

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

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

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

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

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

with  $fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 694.45$

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  
 $l_o/l_{ou,min} = l_b/l_{b,min} = 1.00$   
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$   
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  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
with  $fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 694.45$   
with  $Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$   
 $y_v = 0.0025$   
 $sh_v = 0.008$   
 $ft_v = 833.34$   
 $fy_v = 694.45$   
 $suv = 0.032$   
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  
 $l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$   
From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
with  $fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 694.45$   
with  $Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$   
 $1 = A_{sl,ten} / (b * d) * (fs_1 / f_c) = 0.08015524$   
 $2 = A_{sl,com} / (b * d) * (fs_2 / f_c) = 0.08015524$   
 $v = A_{sl,mid} / (b * d) * (fsv / f_c) = 0.04892233$   
and confined core properties:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = A_{sl,ten} / (b * d) * (fs_1 / f_c) = 0.09611636$   
 $2 = A_{sl,com} / (b * d) * (fs_2 / f_c) = 0.09611636$   
 $v = A_{sl,mid} / (b * d) * (fsv / f_c) = 0.05866412$   
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 Shear Strength  $V_r = Min(V_{r1}, V_{r2}) = 383231.42$

Calculation of Shear Strength at edge 1,  $V_{r1} = 383231.42$   
 $V_{r1} = V_n ((22.5.1.1), ACI 318-14)$

NOTE: In expression (22.5.1.1) '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:  $fc' = (fc'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + fc'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 33.00$ , but  $fc'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 8.6547052E-012$   
 $V_u = 6.9721474E-015$   
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:  
 $d = 160.00$   
 $A_v = 100530.965$   
 $f_y = 555.56$   
 $s = 300.00$   
 $V_{s2}$  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:  $fc' = (fc'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + fc'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 33.00$ , but  $fc'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 1.2266780E-011$   
 $V_u = 6.9721474E-015$   
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,  $\phi = 1.00$

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  $135^\circ$ )

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ( $l_b/l_d \geq 1$ )

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:  $As_t = 709.9999$

-Compression:  $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{t,ten} = 911.0619$

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

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

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{t,ten,jacket} = 603.1858$

-Compression:  $As_{l,com,jacket} = 603.1858$

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

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

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

-Compression:  $As_{l,com,core} = 307.8761$

-Middle:  $As_{l,mid,core} = 153.938$

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  $y$  -

$y = (M_y * L_s / 3) / E_{eff} = 0.0034424 \text{ ((4.29), Biskinis Phd)}$

$M_y = 1.9927E+008$   
 $L_s = M/V$  (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  $y$  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  $p_t = 0.00380895$   
 $p_c = 0.00380895$   
 $p_v = 0.00232477$   
 $N = 4363.489$   
 $b = 670.00$   
 $" = 0.12044818$   
 $y_{comp} = 2.7617879E-005$   
 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 $I_b/I_d$

Adequate Lap Length:  $I_b/I_d \geq 1$

- Calculation of  $p$  -

From table 10-7:  $p = 0.005$

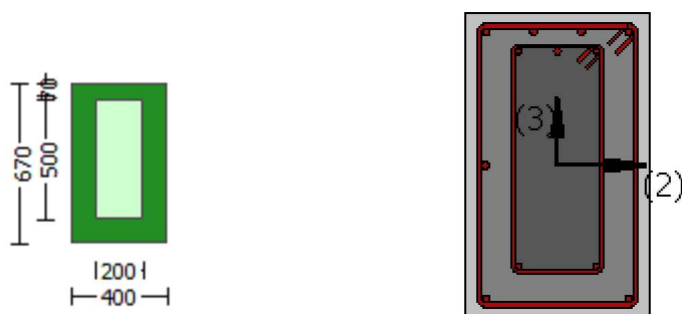
with:

- Condition i occurred  
Beam controlled by flexure:  $V_p/V_o \leq 1$   
shear control ratio  $V_p/V_o = 0.53480887$
- Transverse Reinforcement: NC
- Stirrup Spacing  $> d/3$
- Low ductility demand,  $\rho_y < 2$  (table 10-6, ASCE 41-17)  
 $\rho_y = 1.5731932E-022$
- 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 =  $8.4049242E-014$
- $(\rho_t - \rho_y)/\rho_{bal} = -0.23508921$   
 $\rho_t = A_{st}/(b_w*d) = 0.00296835$   
Tension Reinf Area:  $A_{st} = 709.9999$   
 $\rho_c = A_{sc}/(b_w*d) = 0.00697431$   
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:  $\rho_t = 0.65$   
From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + \rho_y) = 0.51922877$   
 $\rho_y = 0.0027778$
- $V/(b_w*d*f_c^{0.5}) = 7.3664296E-019$ , 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  $VR_d$   
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:  $A_{st,com} = 911.0619$   
   -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) ' $V_w$ ' 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  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 9.4153455E-011$   
 $V_u = 8.4049242E-014$   
 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

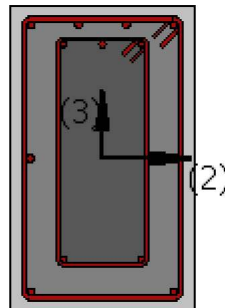
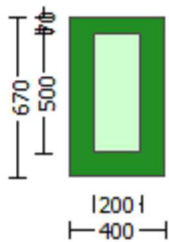
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

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 ( $l_o/l_{ou,min} \geq 1$ )

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:  $A_{st,com} = 1266.062$

-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

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

$\mu_{u1+} = 4.3734E+008$ , 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

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

$\mu_{u2+} = 4.3734E+008$ , 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:

$$u = 5.6088283E-005$$

$$Mu = 4.3734E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

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

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

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

$$w_e (5.4c) = 0.00563796$$

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

$$a_{se1} = 0.14776895$$

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

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

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

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

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

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

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

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

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

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

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

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$f_{t1} = 833.34$$

$$f_{y1} = 694.45$$

$$su_1 = 0.032$$

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

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

$$su_1 = 0.4 * esu_1_{\text{nominal}} ((5.5), \text{TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu_1_{\text{nominal}} = 0.08,$$

For calculation of  $esu1\_nominal$  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

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

$su2 = 0.4 \cdot esu2\_nominal \cdot ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08$

For calculation of  $esu2\_nominal$  and  $y2, sh2, ft2, fy2$ , it is considered characteristic value  $fsy2 = fs2/1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , 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

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

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

From table 5A.1, TBDY:  $esuv\_nominal = 0.08$

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

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

$y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , 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  $Es_v = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$

$1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.05957415$   
 $2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.10623177$   
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.03374111$

and confined core properties:

$b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.0736092$   
 $2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.13125889$   
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.04169017$

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  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

$$\phi_u = 5.9367084E-005$$

$$\mu = 7.4472E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

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

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

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

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

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

$$\phi_{ase1} = 0.14776895$$

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

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

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

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

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

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

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

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

$$\phi_{psh, x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{ps2} * F_{ywe2} = 2.25223$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$\phi_{psh, y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{ps2} * F_{ywe2} = 1.25908$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

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

```

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 fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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 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:

$$\mu = 5.6088283E-005$$

$$\mu_{2+} = 4.3734E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$\mu_{2+} \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu_{2+}: \mu_{2+}^* = \text{shear\_factor} * \text{Max}(\mu_{2+}, \mu_{2+}^*) = 0.00650345$$

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

$$\text{From (5.4b), TBDY: } \mu_{2+} = 0.00650345$$

$$\mu_{2+} \text{ (5.4c)} = 0.00563796$$

$$\mu_{2+} \text{ ((5.4d), TBDY)} = (\mu_{2+1} * A_{ext} + \mu_{2+2} * A_{int}) / A_{sec} = 0.14776895$$

$$\mu_{2+1} = 0.14776895$$

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

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

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

$$\mu_{2+2} = \text{Max}(\mu_{2+1}, \mu_{2+2}) = 0.14776895$$

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

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

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

$$\mu_{2+}^* = \text{Min}(\mu_{2+}^*, \mu_{2+}^*) = 1.25908$$

$$\mu_{2+}^* = \mu_{2+1}^* + \mu_{2+2}^* = 2.25223$$

$$\mu_{2+1}^* \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

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

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

$$h_1 = 670.00$$

$$\mu_{2+2}^* \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

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

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

$$h_2 = 500.00$$

$$\mu_{2+}^* = \mu_{2+1}^* + \mu_{2+2}^* = 1.25908$$

$$\mu_{2+1}^* \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

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

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

$$h_1 = 400.00$$

$$\mu_{2+2}^* \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \mu_{2+} = 0.00232446$$

$$\mu_{2+} = \text{confinement factor} = 1.03245$$

$$y_1 = 0.0025$$

$$s_1 = 0.008$$

$$f_{t1} = 833.34$$

```

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 fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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  $\mu_u$

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

$$\mu_u = 5.9367084E-005$$

$$\mu_u = 7.4472E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

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

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

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

$$\mu_u (5.4c) = 0.00563796$$

$$\alpha_e ((5.4d), \text{TB DY}) = (\alpha_e1 * A_{ext} + \alpha_e2 * A_{int}) / A_{sec} = 0.14776895$$

$$\alpha_e1 = 0.14776895$$

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

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

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

$$\alpha_e2 = \text{Max}(\alpha_e1, \alpha_e2) = 0.14776895$$

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

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

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

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

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

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

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

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TB DY), TB DY: } \mu_c = 0.00232446$$

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

```

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 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 fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 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 Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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  $l_b/l_d$

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

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

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

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

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

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

= 1 (normal-weight concrete)

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

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

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

$$b_w = 400.00$$

$$d = 536.00$$

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

$$\mu_u = 1.0197E+006$$

$$V_u = 9840.633$$

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:

$$d_2 = 400.00$$

$$A_v = 100530.965$$

$$f_y = 555.56$$

$$s = 300.00$$

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

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

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

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

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

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

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

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

= 1 (normal-weight concrete)

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

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

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

$$b_w = 400.00$$

$$d = 536.00$$

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

$$\mu_u = 1.0197E+006$$

$$V_u = 9840.633$$

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)  
     $2(1-s/d) = 0.50$   
     $V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$   
    From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

-----

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

-----

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

Constant Properties

-----

Knowledge Factor,  $\phi = 1.00$   
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 ( $l_o/l_{ou, \min} \geq 1$ )  
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:  $As_{l,com} = 911.0619$

-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 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 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 static loading combination

$V_2 = 6.9721474E-015$ , is the shear force acting at edge 2 for 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  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00650345$

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

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

$w_e (5.4c) = 0.00563796$

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

$ase1 = 0.14776895$

$bo_1 = 340.00$

$ho_1 = 610.00$

$bi2_1 = 975400.00$

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

bo\_2 = 192.00  
ho\_2 = 492.00  
bi2\_2 = 557856.00  
psh,min\*Fywe = 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,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
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,min = lb/ld = 1.00
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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 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
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

```

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

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

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

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

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  
 $\text{Shear\_factor} = 1.00$

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

$su1 = 0.4 * esu1\_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

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

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

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

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

$su2 = 0.4 * esu2\_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

```

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 Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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 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

```

$ase((5.4d), TBDY) = (ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo_1 = 340.00$   
 $ho_1 = 610.00$   
 $bi2_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo_2 = 192.00$   
 $ho_2 = 492.00$   
 $bi2_2 = 557856.00$   
 $psh_{min} \cdot F_{ywe} = \text{Min}(psh_x \cdot F_{ywe}, psh_y \cdot F_{ywe}) = 1.25908$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

For calculation of  $esu2_{nominal}$  and  $y2, sh2, ft2, fy2$ , it is considered



characteristic value  $f_{s2} = f_{s2}/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $f_{s2} = (f_{sjacket} \cdot A_{sl,com,jacket} + f_{s,core} \cdot A_{sl,com,core}) / A_{sl,com} = 694.45$   
 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  $f_{sv} = f_{sv}/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $f_{sv} = f_{sv}/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , 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:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.09611636$   
 $2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.09611636$   
 $v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.05866412$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' does not satisfy Eq. (4.3)  
 --->  
 $v < v_{s,c}$  - RHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.13857861$   
 $Mu = MR_c (4.14) = 3.0743E+008$   
 $u = su (4.1) = 0.00010406$

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:  $c_u = 0.00650345$

$w_e$  (5.4c) = 0.00563796

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

$a_{se1} = 0.14776895$

$b_{o\_1} = 340.00$

$h_{o\_1} = 610.00$

$b_{i2\_1} = 975400.00$

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

$b_{o\_2} = 192.00$

$h_{o\_2} = 492.00$

$b_{i2\_2} = 557856.00$

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

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

$p_{s1}$  (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) =  $(A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00062519$

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

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

$h_2 = 500.00$

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

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

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

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

$h_1 = 400.00$

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

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

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

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

$su_1 = 0.4 \cdot esu_{1\_nominal}$  ((5.5), TBDY) = 0.032

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

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

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

with  $fs_1 = (f_{s, \text{jacket}} \cdot A_{s, \text{ten, jacket}} + f_{s, \text{core}} \cdot A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 694.45$

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

$y_2 = 0.0025$

$sh_2 = 0.008$

$ft_2 = 833.34$

$fy_2 = 694.45$

$su_2 = 0.032$

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

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

$su_2 = 0.4 \cdot esu_{2\_nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esu_{2\_nominal} = 0.08$ ,  
 For calculation of  $esu_{2\_nominal}$  and  $y_2, sh_2, ft_2, fy_2$ , it is considered  
 characteristic value  $fsy_2 = fs_2/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 694.45$   
 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  
 $lo/lo_{u,min} = lb/ld = 1.00$   
 $suv = 0.4 \cdot esuv\_nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv\_nominal = 0.08$ ,  
 considering characteristic value  $fsyv = fs_v/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv\_nominal$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fsyv = fs_v/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_v = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 694.45$   
 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:

$b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.09611636$   
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.09611636$   
 $v = Asl_{mid} / (b \cdot d) \cdot (fs_v / fc) = 0.05866412$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

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

--->

$su (4.9) = 0.13857861$

$\mu_u = MR_c (4.14) = 3.0743E+008$

$u = su (4.1) = 0.00010406$

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

$pw = As / (bw \cdot d) = 0.00331157$

As (tension reinf.) = 709.9999

bw = 670.00

d = 320.00

$V_u \cdot d / \mu < 1 = 0.00$

$\mu = 8.6547052E-012$

$V_u = 6.9721474E-015$

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 ' $V_w + f \cdot V_f$ '  
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)

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

As (tension reinf.) = 709.9999

bw = 670.00

d = 320.00

$V_u \cdot d / \mu < 1 = 0.00$

$\mu = 1.2266780E-011$

$V_u = 6.9721474E-015$

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  $135^\circ$ )  
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,  $M = 1.5895E+007$   
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:  $As_t = 709.9999$   
-Compression:  $As_c = 1668.186$   
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $As_{t,ten} = 709.9999$   
-Compression:  $As_{l,com} = 1266.062$   
-Middle:  $As_{l,mid} = 402.1239$   
Longitudinal External Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $As_{t,ten,jacket} = 402.1239$   
-Compression:  $As_{l,com,jacket} = 804.2477$   
-Middle:  $As_{l,mid,jacket} = 402.1239$   
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $As_{t,ten,core} = 307.8761$   
-Compression:  $As_{l,com,core} = 461.8141$   
-Middle:  $As_{l,mid,core} = 0.00$   
Mean Diameter of Tension Reinforcement,  $Db_L = 15.00$

New component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $\phi_{u,R} = 1.0^*$   $\phi_u = 0.01094898$   
 $\phi_u = \phi_y + \phi_p = 0.01094898$

- Calculation of  $\phi_y$  -

$\phi_y = (M_y * L_s / 3) / E_{eff} = 0.00094898$  ((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 = Min( y_ten, y_com)
y_ten = 5.4349766E-006
with fy = 555.56
d = 627.00
y = 0.18485333
A = 0.00951372
B = 0.00406512
with pt = 0.00283094
pc = 0.00504809
pv = 0.00160336
N = 4363.489
b = 400.00
" = 0.06858054
y_comp = 1.9036374E-005
with fc = 33.00
Ec = 26999.444
y = 0.18432314
A = 0.00944286
B = 0.0040338
with Es = 200000.00
```

### Calculation of ratio $I_b/I_d$

Adequate Lap Length:  $I_b/I_d \geq 1$

- 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,  $\rho_y < 2$  (table 10-6, ASCE 41-17)  
 $\rho_y = 9.5960011E-006$
- Stirrup Spacing  $\leq d/2$   
 $d = d_{\text{external}} = 627.00$   
 $s = s_{\text{external}} = 150.00$
- Strength provided by hoops  $V_s < 3/4 \times \text{design Shear}$   
 $V_s = 386302.632$ , already given in calculation of shear control ratio  
design Shear = 18821.487
- $(\rho - \rho_y)/\rho_{\text{bal}} = -0.22420649$   
 $\rho_{\text{bal}} = A_{\text{st}}/(b_w \times d) = 0.00283094$   
Tension Reinf Area:  $A_{\text{st}} = 709.9999$   
 $\rho_y = A_{\text{sc}}/(b_w \times d) = 0.00665146$   
Compression Reinf Area:  $A_{\text{sc}} = 1668.186$   
From (B-1), ACI 318-11:  $\rho_{\text{bal}} = 0.01704017$   
 $\rho_{\text{fc}} = (\rho_{\text{fc\_jacket}} \times \text{Area\_jacket} + \rho_{\text{fc\_core}} \times \text{Area\_core})/\text{section\_area} = 33.00$   
 $\rho_y = \rho_{\text{fy\_jacket\_bars}} = 555.56$   
From 10.2.7.3, ACI 318-11:  $\rho_1 = 0.65$   
From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000/(87000 + \rho_y) = c_b/d_t = 0.003/(0.003 + \rho_y) = 0.51922877$   
 $\rho_y = 0.0027778$
- $V/(b_w \times d \times \rho_{\text{fc}}^{0.5}) = 0.15732316$ , 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

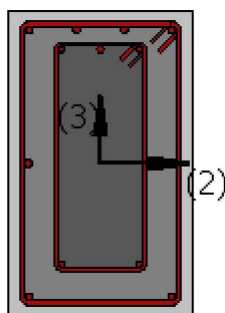
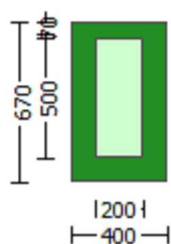
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity  $V_{Rd}$

Edge: End

Local Axis: (3)



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

At local axis: 3

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

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:  $A_{st,com} = 1266.062$   
   -Middle:  $A_{st,mid} = 402.1239$   
 Mean Diameter of Tension Reinforcement,  $Db_{L,ten} = 15.00$

New component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $V_R = 1.0 \cdot V_n = 493339.696$   
 $V_n$  ((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).

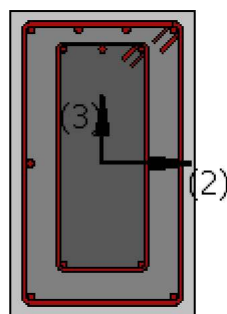
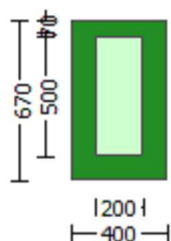
From Table (22.5.5.1), ACI 318-14:  $V_c = 179180.43$   
   = 1 (normal-weight concrete)  
 Mean concrete strength:  $f'_c = (f'_{c,jacket} \cdot Area_{jacket} + f'_{c,core} \cdot Area_{core}) / Area_{section} = 25.00$ , but  $f'_c^{0.5} \leq 8.3$   
 MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (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 (  $\phi$  )  
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:  $A_{st,com} = 1266.062$   
-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  
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 7.4472E+008$   
 $\mu_{u1+} = 4.3734E+008$ , 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  
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 7.4472E+008$   
 $\mu_{u2+} = 4.3734E+008$ , 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  $\mu_u$  according to 4.1, Biskinis/Fardis 2013:  
 $\mu_u = 5.6088283E-005$

$$\mu = 4.3734E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

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

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

$$\text{From (5.4b), TB DY: } \phi = 0.00650345$$

$$\phi_e (5.4c) = 0.00563796$$

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

$$\phi_{se1} = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i21} = 975400.00$$

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

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i22} = 557856.00$$

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

$$\phi_{sh, x} * \phi_{ywe} = \phi_{sh1} * \phi_{ywe1} + \phi_{sh2} * \phi_{ywe2} = 2.25223$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$\phi_{sh, y} * \phi_{ywe} = \phi_{sh1} * \phi_{ywe1} + \phi_{sh2} * \phi_{ywe2} = 1.25908$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$\phi_{ywe1} = 694.45$$

$$\phi_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TB DY), TB DY: } \phi_c = 0.00232446$$

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor

and also multiplied by the shear\_factor according to 15.7.1.4, with

$$\text{Shear\_factor} = 1.00$$

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

$$su_1 = 0.4 * esu_1_{\text{nominal}} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu_1_{\text{nominal}} = 0.08,$$

For calculation of  $esu_1_{\text{nominal}}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered

characteristic value  $fsy_1 = fs_1 / 1.2$ , from table 5.1, TB DY.

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

```

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 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 fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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/lb

Adequate Lap Length: lb/lb >= 1

Calculation of Mu1-

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:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

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

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

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

$$w_e (5.4c) = 0.00563796$$

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

$$a_{se1} = 0.14776895$$

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

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

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

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

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

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

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

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

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

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

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

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$f_{t1} = 833.34$$

$$f_{y1} = 694.45$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor

and also multiplied by the shear\_factor according to 15.7.1.4, with

$$\text{Shear\_factor} = 1.00$$

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

$$su_1 = 0.4 * esu_1_{\text{nominal}} ((5.5), \text{TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu_1_{\text{nominal}} = 0.08,$$

For calculation of  $esu1\_nominal$  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

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

$su2 = 0.4 \cdot esu2\_nominal \cdot ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08$ ,

For calculation of  $esu2\_nominal$  and  $y2, sh2, ft2, fy2$ , it is considered characteristic value  $fsy2 = fs2/1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , 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

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

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

From table 5A.1, TBDY:  $esuv\_nominal = 0.08$ ,

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

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

$y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , 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:

$b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = Asl\_ten / (b \cdot d) \cdot (fs1 / fc) = 0.13125889$   
 $2 = Asl\_com / (b \cdot d) \cdot (fs2 / fc) = 0.0736092$   
 $v = Asl\_mid / (b \cdot d) \cdot (fsv / fc) = 0.04169017$

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 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:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

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

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

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

$$w_e(5.4c) = 0.00563796$$

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

$$a_{se1} = 0.14776895$$

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

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

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

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

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

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

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

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

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

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

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

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

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  
 $l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $su_1 = 0.4 * esu_{1,nominal} ((5.5), TBDY) = 0.032$   
From table 5A.1, TBDY:  $esu_{1,nominal} = 0.08$ ,  
For calculation of  $esu_{1,nominal}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered  
characteristic value  $fsy_1 = fs_1/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
with  $fs_1 = (fs_{jacket} * Asl_{ten,jacket} + fs_{core} * Asl_{ten,core}) / Asl_{ten} = 694.45$   
with  $Es_1 = (Es_{jacket} * Asl_{ten,jacket} + Es_{core} * Asl_{ten,core}) / Asl_{ten} = 200000.00$   
 $y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$   
 $fy_2 = 694.45$   
 $su_2 = 0.032$   
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  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
with  $fs_2 = (fs_{jacket} * Asl_{com,jacket} + fs_{core} * Asl_{com,core}) / Asl_{com} = 694.45$   
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  
 $l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$   
From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
with  $fsv = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 694.45$   
with  $Esv = (Es_{jacket} * Asl_{mid,jacket} + Es_{mid} * Asl_{mid,core}) / Asl_{mid} = 200000.00$   
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.05957415$   
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.10623177$   
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.03374111$   
and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.0736092$   
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.13125889$   
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.04169017$   
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:  $l_b/d \geq 1$

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:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$\mu_0 \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu_2: \mu_2^* = \text{shear\_factor} * \text{Max}(\mu_0, \mu_0) = 0.00650345$$

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

$$\text{From (5.4b), TBDY: } \mu_2 = 0.00650345$$

$$\mu_2 \text{ (5.4c)} = 0.00563796$$

$$\mu_2 \text{ ((5.4d), TBDY)} = (\mu_2^* A_{ext} + \mu_2^* A_{int}) / A_{sec} = 0.14776895$$

$$\mu_2^1 = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i1} = 975400.00$$

$$\mu_2^2 = \text{Max}(\mu_2^1, \mu_2^2) = 0.14776895$$

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i2} = 557856.00$$

$$\mu_2^{\min} * F_{ywe} = \text{Min}(\mu_2^x * F_{ywe}, \mu_2^y * F_{ywe}) = 1.25908$$

$$\mu_2^x * F_{ywe} = \mu_2^1 * F_{ywe1} + \mu_2^2 * F_{ywe2} = 2.25223$$

$$\mu_2^1 \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

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

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

$$h_1 = 670.00$$

$$\mu_2^2 \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

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

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

$$h_2 = 500.00$$

$$\mu_2^y * F_{ywe} = \mu_2^1 * F_{ywe1} + \mu_2^2 * F_{ywe2} = 1.25908$$

$$\mu_2^1 \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

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

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

$$h_1 = 400.00$$

$$\mu_2^2 \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \mu_2 = 0.00232446$$

$$\mu_2 = \text{confinement factor} = 1.03245$$

$$y_1 = 0.0025$$

$$s_1 = 0.008$$

$$f_{t1} = 833.34$$

```

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 fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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

```

$$\begin{aligned} \mu &= MRC(4.15) = 7.4472E+008 \\ u &= su(4.1) = 5.9367084E-005 \end{aligned}$$

Calculation of ratio  $l_b/l_d$

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

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

Calculation of Shear Strength at edge 1,  $V_{r1} = 558200.119$   
 $V_{r1} = V_n$  ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
 $= 1$  (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 33.00$ , but  $f'_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (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 ' $V_w + f^*V_f$ ' where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
 $= 1$  (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 33.00$ , but  $f'_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (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:  
 $d = 536.00$

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:  $V_s + V_f \leq 818179.336$

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

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: 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:  $As_{l,com} = 911.0619$   
   -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 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 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 static loading combination  
 $V_2 = 6.9721474E-015$ , is the shear force acting at edge 2 for 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) =  $(ase1 \cdot A_{ext} + ase2 \cdot A_{int})/A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo\_1 = 340.00$   
 $ho\_1 = 610.00$   
 $bi2\_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$

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

$$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.25223$$

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

$$Ash1 = Astir_1*ns_1 = 157.0796$$

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

$$h1 = 670.00$$

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

$$Ash2 = Astir_2*ns_2 = 100.531$$

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

$$h2 = 500.00$$

$$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.25908$$

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

$$Ash1 = Astir_1*ns_1 = 157.0796$$

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

$$h1 = 400.00$$

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

$$Ash2 = Astir_2*ns_2 = 100.531$$

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

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 694.45$$

$$fce = 33.00$$

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

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

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 833.34$$

$$fy1 = 694.45$$

$$su1 = 0.032$$

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

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

$$su1 = 0.4*esu1\_nominal ((5.5), \text{ TBDY}) = 0.032$$

From table 5A.1, TBDY: esu1\_nominal = 0.08,

For calculation of esu1\_nominal and y1, sh1,ft1,fy1, it is considered  
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

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

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

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

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 833.34$$

$$fy2 = 694.45$$

$$su2 = 0.032$$

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

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

$$su2 = 0.4*esu2\_nominal ((5.5), \text{ TBDY}) = 0.032$$

From table 5A.1, TBDY: esu2\_nominal = 0.08,

For calculation of esu2\_nominal and y2, sh2,ft2,fy2, it is considered  
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

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

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

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

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 833.34$$

$$fyv = 694.45$$

$$suv = 0.032$$

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  
 $l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$   
From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
For calculation of  $esuv_{nominal}$  and  $y_v$ ,  $sh_v$ ,  $ft_v$ ,  $fy_v$ , it is considered  
characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y_1$ ,  $sh_1$ ,  $ft_1$ ,  $fy_1$ , are also multiplied by  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
with  $fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 694.45$   
with  $Esv = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$   
 $1 = A_{sl,ten} / (b * d) * (fs_1 / f_c) = 0.08015524$   
 $2 = A_{sl,com} / (b * d) * (fs_2 / f_c) = 0.08015524$   
 $v = A_{sl,mid} / (b * d) * (fsv / f_c) = 0.04892233$   
and confined core properties:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = A_{sl,ten} / (b * d) * (fs_1 / f_c) = 0.09611636$   
 $2 = A_{sl,com} / (b * d) * (fs_2 / f_c) = 0.09611636$   
 $v = A_{sl,mid} / (b * d) * (fsv / f_c) = 0.05866412$   
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  $cu$ :  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00650345$   
The Shear\_factor is considered equal to 1 (pure moment strength)  
From (5.4b), TBDY:  $cu = 0.00650345$   
 $we (5.4c) = 0.00563796$   
 $ase ((5.4d), TBDY) = (ase_1 * A_{ext} + ase_2 * A_{int}) / A_{sec} = 0.14776895$   
 $ase_1 = 0.14776895$   
 $bo_1 = 340.00$   
 $ho_1 = 610.00$   
 $bi_2_1 = 975400.00$   
 $ase_2 = \text{Max}(ase_1, ase_2) = 0.14776895$

bo\_2 = 192.00  
ho\_2 = 492.00  
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,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
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,min = lb/ld = 1.00
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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 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

```

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

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

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

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

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  
 $\text{Shear\_factor} = 1.00$

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

$su1 = 0.4 * esu1\_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

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

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

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

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

$su2 = 0.4 * esu2\_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

```

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 Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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 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

```

$ase((5.4d), TBDY) = (ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo_1 = 340.00$   
 $ho_1 = 610.00$   
 $bi2_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo_2 = 192.00$   
 $ho_2 = 492.00$   
 $bi2_2 = 557856.00$   
 $psh, \min \cdot Fywe = \text{Min}(psh, x \cdot Fywe, psh, y \cdot Fywe) = 1.25908$

$psh, x \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 2.25223$   
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.00261799$   
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$   
 $\text{No stirups, } ns_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00062519$   
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$   
 $\text{No stirups, } ns_2 = 2.00$   
 $h2 = 500.00$

$psh, y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.25908$   
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.00156298$   
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$   
 $\text{No stirups, } ns_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00025008$   
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$   
 $\text{No stirups, } ns_2 = 2.00$   
 $h2 = 200.00$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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  $f_{sy2} = f_{s2}/1.2$ , 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:

$b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.09611636$   
 $2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.09611636$   
 $v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.05866412$

Case/Assumption: Unconfined full section - Steel rupture  
 ' does not satisfy Eq. (4.3)

--->  
 $v < v_{s,c}$  - RHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.13857861$   
 $Mu = MR_c (4.14) = 3.0743E+008$   
 $u = su (4.1) = 0.00010406$

Calculation of ratio  $l_b/l_d$

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

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

Calculation of Shear Strength at edge 1,  $V_{r1} = 383231.42$   
 $V_{r1} = V_n ((22.5.1.1), ACI 318-14)$

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

From Table (22.5.5.1), ACI 318-14:  $V_c = 197061.477$   
 $= 1$  (normal-weight concrete)

Mean concrete strength:  $f'_c = (f'_{c,jacket} \cdot \text{Area}_{jacket} + f'_{c,core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$ , but  $f'_c^{0.5} \leq 8.3$   
 MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$

$$V_u \cdot d / \mu_u < 1 = 0.00$$

$$\mu_u = 8.6547052E-012$$

$$V_u = 6.9721474E-015$$

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)

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

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

Calculation of Shear Strength at edge 2,  $V_{r2} = 383231.42$

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

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).

$$\text{From Table } (22.5.5.1), \text{ACI } 318-14: V_c = 197061.477$$

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

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

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

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

$$b_w = 670.00$$

$$d = 320.00$$

$$V_u \cdot d / \mu_u < 1 = 0.00$$

$$\mu_u = 1.2266780E-011$$

$$V_u = 6.9721474E-015$$

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)

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

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

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,  $M = -9.4153455E-011$

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 = Min( y_ten, y_com)
y_ten = 1.0021098E-005
with fy = 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
" = 0.12044818
y_comp = 2.7617879E-005
with fc = 33.00
Ec = 26999.444
y = 0.22313777
A = 0.0099012
B = 0.00557012
with Es = 200000.00
```

Calculation of ratio  $I_b/I_d$

Adequate Lap Length:  $I_b/I_d \geq 1$

- 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,  $\rho_y < 2$  (table 10-6, ASCE 41-17)  
 $\rho_y = 4.3544309E-022$
- Stirrup Spacing  $\leq d/2$   
 $d = d_{\text{external}} = 357.00$   
 $s = s_{\text{external}} = 150.00$
- Strength provided by hoops  $V_s < 3/4 \times \text{design Shear}$   
 $V_s = 215957.134$ , already given in calculation of shear control ratio  
design Shear =  $8.4049242E-014$
- $(\rho_t - \rho'_t)/\rho_{bal} = -0.23508921$   
 $\rho_t = A_{st}/(b_w \times d) = 0.00296835$   
Tension Reinf Area:  $A_{st} = 709.9999$   
 $\rho'_t = A_{sc}/(b_w \times d) = 0.00697431$   
Compression Reinf Area:  $A_{sc} = 1668.186$   
From (B-1), ACI 318-11:  $\rho_{bal} = 0.01704017$   
 $\rho_{fc} = (f_{c\_jacket} \times \text{Area}_{jacket} + f_{c\_core} \times \text{Area}_{core}) / \text{section\_area} = 33.00$   
 $\rho_{fy} = \rho_{fy\_jacket\_bars} = 555.56$   
From 10.2.7.3, ACI 318-11:  $\rho_t = 0.65$   
From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000/(87000 + \rho_{fy}) = c_b/d_t = 0.003/(0.003 + \rho_y) = 0.51922877$   
 $\rho_y = 0.0027778$
- $V/(b_w \times d \times \rho_{fc}^{0.5}) = 7.3664296E-019$ , 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: (b)



## Calculation No. 9

beam B1, Floor 1

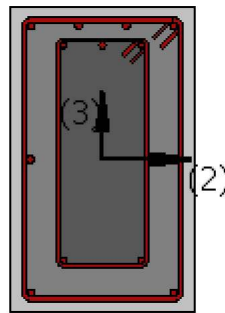
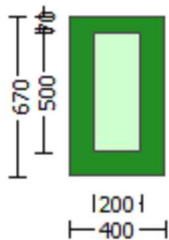
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity  $V_{Rd}$

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

#### 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:  $A_{st} = 709.9999$   
   -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:  $A_{st,mid} = 556.0619$   
 Mean Diameter of Tension Reinforcement,  $D_{bL,ten} = 15.20$

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

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

From Table (22.5.5.1), ACI 318-14:  $V_c = 171520.00$   
 = 1 (normal-weight concrete)  
 Mean concrete strength:  $f'_c = (f'_c_{jacket} \cdot Area_{jacket} + f'_c_{core} \cdot Area_{core}) / Area_{section} = 25.00$ , but  $f'_c^{0.5} \leq 8.3$   
 MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 1.0550018E-010$   
 $V_u = 5.6924552E-014$   
 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

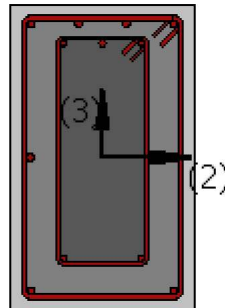
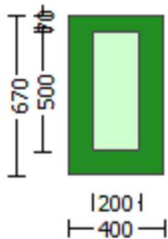
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (  $\phi$  )

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 ( $l_o/l_{ou,min} \geq 1$ )  
 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:  $As_t = 709.9999$   
   -Compression:  $As_c = 1668.186$   
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $As_{t,ten} = 709.9999$   
   -Compression:  $As_{l,com} = 1266.062$   
   -Middle:  $As_{l,mid} = 402.1239$

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  
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 7.4472E+008$   
 $Mu_{1+} = 4.3734E+008$ , 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  
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$   
 with  
 $V_1 = 9840.633$ , is the shear force acting at edge 1 for the the static loading combination  
 $V_2 = 9840.633$ , is the shear force acting at edge 2 for the the static loading combination

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

Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:  
 $\phi_u = 5.6088283E-005$   
 $Mu = 4.3734E+008$

with full section properties:  
 $b = 400.00$

$d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $co (5A.5, TBDY) = 0.002$   
 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:  $cu = 0.00650345$   
 $we (5.4c) = 0.00563796$   
 $ase ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo_1 = 340.00$   
 $ho_1 = 610.00$   
 $bi2_1 = 975400.00$   
 $ase2 = Max(ase1, ase2) = 0.14776895$   
 $bo_2 = 192.00$   
 $ho_2 = 492.00$   
 $bi2_2 = 557856.00$   
 $psh, min * F_{ywe} = Min(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.25908$

$psh, x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25223$   
 $ps1 (external) = (Ash1 * h1 / s1) / A_{sec} = 0.00261799$   
 $Ash1 = Astir_1 * ns_1 = 157.0796$   
 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,  $ns_2 = 2.00$   
 $h2 = 200.00$

$A_{sec} = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$

$fy_{we1} = 694.45$   
 $fy_{we2} = 694.45$   
 $f_{ce} = 33.00$

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

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

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
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,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,min = lb/lb = 1.00
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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/lb

Adequate Lap Length: lb/lb >= 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:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

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

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

$$\text{From (5.4b), TB DY: } \alpha_c = 0.00650345$$

$$\alpha_w (5.4c) = 0.00563796$$

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

$$\alpha_{se1} = 0.14776895$$

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

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

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

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

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

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

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

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

$$psh, x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25223$$

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

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

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

$$h1 = 670.00$$

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

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

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

$$h2 = 500.00$$

$$psh, y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25908$$

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

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

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

$$h1 = 400.00$$

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

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

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

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TB DY), TB DY: } \alpha_c = 0.00232446$$

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

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 833.34$$

$$fy1 = 694.45$$

$$su1 = 0.032$$

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

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

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

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

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

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

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

```

with Es1 = (Es,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 fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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 lb/lb

Adequate Lap Length: lb/lb >= 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:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

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

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

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

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

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

$$\phi_{se1} = 0.14776895$$

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

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

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

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

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

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

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

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

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

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

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

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$f_{t1} = 833.34$$

$$f_{y1} = 694.45$$

$$su_1 = 0.032$$

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

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

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

From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,  
For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered  
characteristic value  $fsy1 = fs1/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25 \cdot (lb/ld)^{2/3})$ , 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  $fsyv = fsv/1.2$ , 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  $Es_v = (Es\_jacket \cdot Asl\_mid\_jacket + Es\_mid \cdot Asl\_mid\_core) / Asl\_mid = 200000.00$   
 $1 = Asl\_ten / (b \cdot d) \cdot (fs1 / fc) = 0.05957415$   
 $2 = Asl\_com / (b \cdot d) \cdot (fs2 / fc) = 0.10623177$   
 $v = Asl\_mid / (b \cdot d) \cdot (fsv / fc) = 0.03374111$   
and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = Asl\_ten / (b \cdot d) \cdot (fs1 / fc) = 0.0736092$   
 $2 = Asl\_com / (b \cdot d) \cdot (fs2 / fc) = 0.13125889$   
 $v = Asl\_mid / (b \cdot d) \cdot (fsv / fc) = 0.04169017$   
Case/Assumption: Unconfined full section - Steel rupture  
' satisfies Eq. (4.3)  
--->  
 $v < vs, y2$  - LHS eq.(4.5) is 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:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

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

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

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

$$\mu_o(5.4c) = 0.00563796$$

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

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

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

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

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

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

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

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

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

$$h1 = 670.00$$

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

$$Ash2 = Astir_2 * ns_2 = 100.531$$

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

$$h2 = 500.00$$

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

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

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

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

$$h1 = 400.00$$

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

$$Ash2 = Astir_2 * ns_2 = 100.531$$

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

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 833.34$$

$$fy1 = 694.45$$

$$su1 = 0.032$$

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 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 fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 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 Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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:  $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 33.00$ , but  $f'_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / \mu_u < 1 = 1.00$   
 $\mu_u = 1.0197\text{E}+006$   
 $V_u = 9840.633$   
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:  $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 33.00$ , but  $f'_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / \mu_u < 1 = 1.00$   
 $\mu_u = 1.0197\text{E}+006$   
 $V_u = 9840.633$   
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:  
 $d = 400.00$   
 $A_v = 100530.965$   
 $f_y = 555.56$   
 $s = 300.00$   
Vs2 has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)  
 $2(1-s/d) = 0.50$   
 $V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$   
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,  $f_s = 1.25 \cdot f_{sm} = 694.45$   
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 ( $l_o/l_{ou, \min} \geq 1$ )  
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:  $As_{ten} = 911.0619$

-Compression:  $As_{com} = 911.0619$

-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 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 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 static loading combination

$V_2 = 6.9721474E-015$ , is the shear force acting at edge 2 for 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:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$f_c = 33.00$

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

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), TB DY:  $\phi_u = 0.00650345$

$w_e (5.4c) = 0.00563796$

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

$a_{se1} = 0.14776895$

$bo_1 = 340.00$

$ho_1 = 610.00$

$bi2_1 = 975400.00$

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

$bo_2 = 192.00$

$ho_2 = 492.00$

$bi2_2 = 557856.00$

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

$psh_x \cdot F_{ywe} = psh_1 \cdot F_{ywe1} + psh_2 \cdot F_{ywe2} = 2.25223$

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

$Ash1 = Astir\_1 * ns\_1 = 157.0796$   
 No stirups,  $ns\_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00062519$   
 $Ash2 = Astir\_2 * ns\_2 = 100.531$   
 No stirups,  $ns\_2 = 2.00$   
 $h2 = 500.00$

$psh\_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.25908$   
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00156298$   
 $Ash1 = Astir\_1 * ns\_1 = 157.0796$   
 No stirups,  $ns\_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00025008$   
 $Ash2 = Astir\_2 * ns\_2 = 100.531$   
 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:  $cc = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$

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

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

$su1 = 0.4 * esu1\_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,

For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered  
 characteristic value  $fsy1 = fs1 / 1.2$ , from table 5.1, TBDY.

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

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

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  
 $Shear\_factor = 1.00$

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

$su2 = 0.4 * esu2\_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08$ ,

For calculation of  $esu2\_nominal$  and  $y2, sh2, ft2, fy2$ , it is considered  
 characteristic value  $fsy2 = fs2 / 1.2$ , from table 5.1, TBDY.

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

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

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 Min(1,1.25*(lb/d)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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 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
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

```

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

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

$Asec = 268000.00$

$s1 = 150.00$

$s2 = 300.00$

$fywe1 = 694.45$

$fywe2 = 694.45$

$fce = 33.00$

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

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

$su1 = 0.4 * esu1\_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,

For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered characteristic value  $fsy1 = fs1 / 1.2$ , from table 5.1, TBDY.

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

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

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

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

$su2 = 0.4 * esu2\_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08$ ,

For calculation of  $esu2\_nominal$  and  $y2, sh2, ft2, fy2$ , it is considered characteristic value  $fsy2 = fs2 / 1.2$ , from table 5.1, TBDY.

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

with  $fs2 = (fs\_jacket * Asl, com, jacket + fs\_core * Asl, com, core) / Asl, com = 694.45$

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  
 $l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 694.45$   
 with  $Esv = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$   
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.08015524$   
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.08015524$   
 $v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.04892233$   
 and confined core properties:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.09611636$   
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.09611636$   
 $v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.05866412$   
 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  $l_b/l_d$

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:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $fc = 33.00$   
 $co (5A.5, TBDY) = 0.002$   
 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:  $cu = 0.00650345$   
 $we (5.4c) = 0.00563796$   
 $ase ((5.4d), TBDY) = (ase_1 * A_{ext} + ase_2 * A_{int}) / A_{sec} = 0.14776895$   
 $ase_1 = 0.14776895$   
 $bo_1 = 340.00$   
 $ho_1 = 610.00$   
 $bi_{2,1} = 975400.00$   
 $ase_2 = \text{Max}(ase_1, ase_2) = 0.14776895$   
 $bo_2 = 192.00$

$ho\_2 = 492.00$   
 $bi\_2 = 557856.00$   
 $psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.25908$

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

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

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

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  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou,min = lb/ld = 1.00$

$su1 = 0.4*esu1\_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,

For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered  
 characteristic value  $fsy1 = fs1/1.2$ , from table 5.1, TBDY.

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

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

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  
 $\text{Shear\_factor} = 1.00$

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

$su2 = 0.4*esu2\_nominal \text{ ((5.5), TBDY)} = 0.032$

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  $\text{Min}(1, 1.25*(lb/ld)^{2/3})$ , 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,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 = (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/ld

Adequate Lap Length: lb/ld >= 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 = 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,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
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*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 <= 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:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

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:

$$d_2 = 160.00$$

$$A_v = 100530.965$$

$$f_y = 555.56$$

$$s = 300.00$$

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

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

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

Calculation of Shear Strength at edge 2,  $V_{r2} = 383231.42$

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

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

$$\text{From Table (22.5.5.1), ACI 318-14: } V_c = 197061.477$$

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

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

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

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

$$b_w = 670.00$$

$$d = 320.00$$

$$V_u \cdot d / M_u < 1 = 0.00$$

$$M_u = 1.2266780\text{E-}011$$

$$V_u = 6.9721474\text{E-}015$$

$$\text{From (11.5.4.8), ACI 318-14: } V_{s1} + V_{s2} = 186169.943$$

Vs1 = 186169.943 is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

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:

$$d = 160.00$$

$$A_v = 100530.965$$

$$f_y = 555.56$$

$$s = 300.00$$

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

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

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

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

$$\text{Knowledge Factor, } = 1.00$$

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

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



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 ( $l_b/l_d \geq 1$ )  
 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:  $A_{st,com} = 1266.062$   
   -Middle:  $A_{st,mid} = 402.1239$   
 Longitudinal External Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $A_{st,ten,jacket} = 402.1239$   
   -Compression:  $A_{st,com,jacket} = 804.2477$   
   -Middle:  $A_{st,mid,jacket} = 402.1239$   
 Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $A_{st,ten,core} = 307.8761$   
   -Compression:  $A_{st,com,core} = 461.8141$   
   -Middle:  $A_{st,mid,core} = 0.00$   
 Mean Diameter of Tension Reinforcement,  $Db_L = 15.00$

New component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u_R = 1.0^*$   $u = 0.05189937$   
 $u = y + p = 0.05189937$

- 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 fy = 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  $I_b/I_d$

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

$= 4.7230116E-005$

- Stirrup Spacing  $\leq d/2$

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

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

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

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

design Shear = 4020.289

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

$= A_{s1}/(b_w \cdot d) = 0.00283094$

Tension Reinf Area:  $A_{s1} = 709.9999$

$' = A_{s2}/(b_w \cdot d) = 0.00665146$

Compression Reinf Area:  $A_{s2} = 1668.186$

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

$fc = (fc_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + fc_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{section\_area} = 33.00$

$fy = fy_{\text{jacket\_bars}} = 555.56$

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

From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000/(87000 + fy) = c_b/dt = 0.003/(0.003 + \gamma) = 0.51922877$

$\gamma = 0.0027778$

-  $V/(b_w \cdot d \cdot fc^{0.5}) = 0.03360439$ , 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

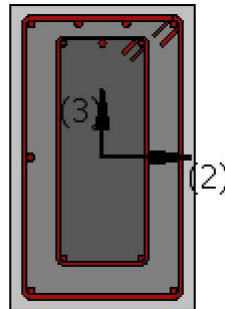
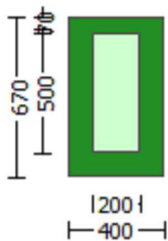
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

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:  $As_{t,ten} = 709.9999$

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

-Middle:  $As_{mid} = 402.1239$

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

New component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $V_R = 1.0 \cdot V_n = 489503.746$   
 $V_n$  ((22.5.1.1), ACI 318-14) = 489503.746

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:  $V_c = 175344.48$

= 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

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / M_u < 1 = 0.31685838$

$M_u = 6.8008E+006$

$V_u = 4020.289$

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

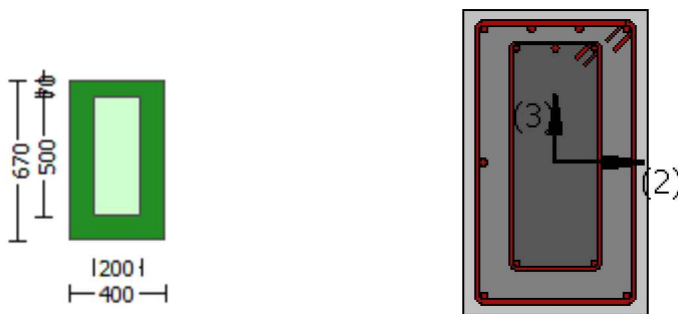
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (  $\phi$  )

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 ( $l_o/l_{ou}, \min \geq 1$ )  
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:  $As_t = 709.9999$   
-Compression:  $As_c = 1668.186$   
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $As_{t,ten} = 709.9999$   
-Compression:  $As_{c,com} = 1266.062$   
-Middle:  $As_{c,mid} = 402.1239$

Calculation of Shear Capacity ratio,  $V_e/V_r = 0.90705729$   
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  
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 7.4472E+008$   
 $\mu_{u1+} = 4.3734E+008$ , 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  
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 7.4472E+008$   
 $\mu_{u2+} = 4.3734E+008$ , 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:

$b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$

$f_c = 33.00$   
 $c_o (5A.5, TBDY) = 0.002$   
 Final value of  $c_u$ :  $c_u^* = \text{shear\_factor} * \text{Max}(c_u, c_o) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $c_u = 0.00650345$   
 $w_e (5.4c) = 0.00563796$   
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$   
 $a_{se1} = 0.14776895$   
 $b_o\_1 = 340.00$   
 $h_o\_1 = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$   
 $b_o\_2 = 192.00$   
 $h_o\_2 = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.25223$   
 $p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 No stirups,  $n_{s\_1} = 2.00$   
 $h_1 = 670.00$   
 $p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$   
 $A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$   
 No stirups,  $n_{s\_2} = 2.00$   
 $h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.25908$   
 $p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 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,  $n_{s\_2} = 2.00$   
 $h_2 = 200.00$

$A_{sec} = 268000.00$   
 $s_1 = 150.00$   
 $s_2 = 300.00$   
 $f_{ywe1} = 694.45$   
 $f_{ywe2} = 694.45$   
 $f_{ce} = 33.00$

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

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

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

From table 5A.1, TBDY:  $esu_{1\_nominal} = 0.08$ ,

For calculation of  $esu_{1\_nominal}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered  
 characteristic value  $fsy_1 = fs_1 / 1.2$ , from table 5.1, TBDY.

$y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs_1 = (f_{s, \text{jacket}} * A_{sl, \text{ten, jacket}} + f_{s, \text{core}} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 694.45$

with  $Es_1 = (E_{s, \text{jacket}} * A_{sl, \text{ten, jacket}} + E_{s, \text{core}} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 200000.00$

$y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$   
 $fy_2 = 694.45$   
 $su_2 = 0.032$

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  
 $l_o/l_{o,min} = l_b/l_{b,min} = 1.00$   
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esu_{2,nominal} = 0.08$ ,  
 For calculation of  $esu_{2,nominal}$  and  $y_2, sh_2, ft_2, fy_2$ , it is considered  
 characteristic value  $fsy_2 = fs_2/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 694.45$   
 with  $Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$   
 $y_v = 0.0025$   
 $sh_v = 0.008$   
 $ft_v = 833.34$   
 $fy_v = 694.45$   
 $suv = 0.032$   
 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  
 $l_o/l_{o,min} = l_b/l_d = 1.00$   
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 694.45$   
 with  $Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$   
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.05957415$   
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.10623177$   
 $v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.03374111$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.0736092$   
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.13125889$   
 $v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.04169017$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < v_{s,y2}$  - 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  $Mu_1$ -

Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:

$$u = 5.9367084E-005$$

$$Mu = 7.4472E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$



$d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $\phi (5A.5, TBDY) = 0.002$   
 Final value of  $\phi$ :  $\phi^* = \text{shear\_factor} * \text{Max}(\phi, \phi_c) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $\phi = 0.00650345$   
 $\phi_e (5.4c) = 0.00563796$   
 $\phi_{se} ((5.4d), TBDY) = (\phi_{se1} * A_{ext} + \phi_{se2} * A_{int}) / A_{sec} = 0.14776895$   
 $\phi_{se1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.25908$

$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.25223$   
 $\phi_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 No stirrups,  $n_{s\_1} = 2.00$   
 $h_1 = 670.00$   
 $\phi_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$   
 $A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$   
 No stirrups,  $n_{s\_2} = 2.00$   
 $h_2 = 500.00$

$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.25908$   
 $\phi_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 No stirrups,  $n_{s\_1} = 2.00$   
 $h_1 = 400.00$   
 $\phi_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$   
 $A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$   
 No stirrups,  $n_{s\_2} = 2.00$   
 $h_2 = 200.00$

$A_{sec} = 268000.00$   
 $s_1 = 150.00$   
 $s_2 = 300.00$

$f_{ywe1} = 694.45$   
 $f_{ywe2} = 694.45$   
 $f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY:  $\phi_c = 0.00232446$   
 $\phi_c = \text{confinement factor} = 1.03245$

$y_1 = 0.0025$   
 $sh_1 = 0.008$   
 $ft_1 = 833.34$   
 $fy_1 = 694.45$   
 $su_1 = 0.032$

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  
 $\phi_{o/\phi_{ou, \min}} = \phi_b / \phi_d = 1.00$

$su_1 = 0.4 * \phi_{su1\_nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY:  $\phi_{su1\_nominal} = 0.08$ ,

For calculation of  $\phi_{su1\_nominal}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered  
 characteristic value  $f_{sy1} = f_{s1} / 1.2$ , from table 5.1, TBDY.

$y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 * (\phi_b / \phi_d)^{2/3})$ , 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  $E_{s1} = (E_{s, \text{jacket}} * A_{s1, \text{ten, jacket}} + E_{s, \text{core}} * A_{s1, \text{ten, core}}) / A_{s1, \text{ten}} = 200000.00$

$y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$

```

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,min = lb/lb,min = 1.00
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 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,min = lb/ld = 1.00
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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 lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 5.6088283E-005

$$\mu = 4.3734E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$\phi (5A.5, \text{TB DY}) = 0.002$$

$$\text{Final value of } \phi: \phi^* = \text{shear\_factor} * \text{Max}(\phi_c, \phi_s) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TB DY: } \phi_c = 0.00650345$$

$$\phi_s (5.4c) = 0.00563796$$

$$A_{se} ((5.4d), \text{TB DY}) = (A_{se1} * A_{ext} + A_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$A_{se1} = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i21} = 975400.00$$

$$A_{se2} = \text{Max}(A_{se1}, A_{se2}) = 0.14776895$$

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i22} = 557856.00$$

$$\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.25908$$

$$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.25223$$

$$\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.25908$$

$$\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TB DY), TB DY: } \phi_c = 0.00232446$$

$$\phi_c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor

and also multiplied by the shear\_factor according to 15.7.1.4, with

$$\text{Shear\_factor} = 1.00$$

$$l_o / l_{o, \min} = l_b / l_d = 1.00$$

$$su_1 = 0.4 * esu_{1, \text{nominal}} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu_{1, \text{nominal}} = 0.08,$$

For calculation of  $esu_{1, \text{nominal}}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered characteristic value  $fsy_1 = fs_1 / 1.2$ , from table 5.1, TB DY.

$y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.

```

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 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 fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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/lb

Adequate Lap Length: lb/lb >= 1

Calculation of Mu2-

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:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$\alpha (5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.00650345$$

$$w_e (5.4c) = 0.00563796$$

$$a_{se} ((5.4d), \text{TBDY}) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$$

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.25223$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.25908$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$f_{t1} = 833.34$$

$$f_{y1} = 694.45$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$l_o / l_{ou, \min} = l_b / l_d = 1.00$$

$$su_1 = 0.4 * esu_1_{\text{nominal}} ((5.5), \text{TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu_1_{\text{nominal}} = 0.08,$$

For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered characteristic value  $fsy1 = fs1/1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25*(lb/ld)^{2/3})$ , 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  $Min(1, 1.25*(lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45$

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  $Min(1, 1.25*(lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45$

with  $Es_v = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$

$1 = Asl,ten/(b*d)*(fs1/fc) = 0.10623177$   
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.05957415$   
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.03374111$

and confined core properties:

$b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.13125889$   
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.0736092$   
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.04169017$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$  - LHS eq.(4.5) is not satisfied

--->

$v < v_{s,c}$  - RHS eq.(4.5) is satisfied

--->

$su (4.8) = 0.1403202$

$Mu = MRc (4.15) = 7.4472E+008$

$u = su (4.1) = 5.9367084E-005$

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 ' $V_w + f^*V_f$ ' 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

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / M_u < 1 = 1.00$

$M_u = 1.0197 \times 10^6$

$V_u = 9840.633$

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 ' $V_w + f^*V_f$ ' 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

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / M_u < 1 = 1.00$

$M_u = 1.0197 \times 10^6$

$V_u = 9840.633$

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:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $\phi_{co} (5A.5, TBDY) = 0.002$   
 Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} \cdot \text{Max}(\phi_u, \phi_{co}) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $\phi_u = 0.00650345$   
 $w_e (5.4c) = 0.00563796$   
 $a_{se} ((5.4d), TBDY) = (a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int})/A_{sec} = 0.14776895$   
 $a_{se1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $p_{sh,min} \cdot F_{ywe} = \text{Min}(p_{sh,x} \cdot F_{ywe}, p_{sh,y} \cdot F_{ywe}) = 1.25908$

$p_{sh,x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{sh2} \cdot F_{ywe2} = 2.25223$   
 $p_{s1} \text{ (external)} = (A_{sh1} \cdot h_1/s_1)/A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} \cdot n_{s\_1} = 157.0796$   
 No stirups,  $n_{s\_1} = 2.00$   
 $h_1 = 670.00$   
 $p_{s2} \text{ (internal)} = (A_{sh2} \cdot h_2/s_2)/A_{sec} = 0.00062519$

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  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , 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  $f_{sv} = f_{sv}/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 694.45$   
 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:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $f_{cc} \text{ (5A.2, TBDY)} = 34.07073$   
 $cc \text{ (5A.5, TBDY)} = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.09611636$   
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.09611636$   
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.05866412$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' does not satisfy Eq. (4.3)  
 --->  
 $v < v_{s,c}$  - RHS eq.(4.5) is satisfied  
 --->  
 $su \text{ (4.9)} = 0.13857861$   
 $Mu = MR_c \text{ (4.14)} = 3.0743E+008$   
 $u = su \text{ (4.1)} = 0.00010406$

-----  
 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:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $co \text{ (5A.5, TBDY)} = 0.002$   
 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:  $cu = 0.00650345$   
 $we \text{ (5.4c)} = 0.00563796$   
 $ase \text{ ((5.4d), TBDY)} = (ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo_1 = 340.00$   
 $ho_1 = 610.00$   
 $bi2_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo_2 = 192.00$   
 $ho_2 = 492.00$   
 $bi2_2 = 557856.00$   
 $psh, \min \cdot F_{ywe} = \text{Min}(psh, x \cdot F_{ywe}, psh, y \cdot F_{ywe}) = 1.25908$   
 -----  
 $psh, x \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 2.25223$   
 $ps1 \text{ (external)} = (A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} \cdot n_{s\_1} = 157.0796$

No stirups,  $ns_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00062519$   
 $Ash2 = Astir\_2 \cdot ns_2 = 100.531$   
 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.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  
 $Shear\_factor = 1.00$

$lo/lou, min = lb/ld = 1.00$

$su1 = 0.4 \cdot esu1\_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,

For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered  
 characteristic value  $fsy1 = fs1/1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs1 = (fs\_jacket \cdot Asl, ten, jacket + fs\_core \cdot Asl, ten, core) / Asl, ten = 694.45$

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  
 $Shear\_factor = 1.00$

$lo/lou, min = lb/lb, min = 1.00$

$su2 = 0.4 \cdot esu2\_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08$ ,

For calculation of  $esu2\_nominal$  and  $y2, sh2, ft2, fy2$ , it is considered  
 characteristic value  $fsy2 = fs2/1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs2 = (fs\_jacket \cdot Asl, com, jacket + fs\_core \cdot Asl, com, core) / Asl, com = 694.45$

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  
 $Shear\_factor = 1.00$

$lo/lou, min = lb/ld = 1.00$

$suv = 0.4 \cdot esuv\_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY:  $esuv\_nominal = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv\_nominal$  and  $yv$ ,  $shv$ ,  $ftv$ ,  $fyv$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y1$ ,  $sh1$ ,  $ft1$ ,  $fy1$ , are also multiplied by  $Min(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs\_jacket \cdot Asl\_mid\_jacket + fs\_mid \cdot Asl\_mid\_core) / Asl\_mid = 694.45$   
 with  $Esv = (Es\_jacket \cdot Asl\_mid\_jacket + Es\_mid \cdot Asl\_mid\_core) / Asl\_mid = 200000.00$   
 $1 = Asl\_ten / (b \cdot d) \cdot (fs1 / fc) = 0.08015524$   
 $2 = Asl\_com / (b \cdot d) \cdot (fs2 / fc) = 0.08015524$   
 $v = Asl\_mid / (b \cdot d) \cdot (fsv / fc) = 0.04892233$

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  
 $c$  = confinement factor = 1.03245  
 $1 = Asl\_ten / (b \cdot d) \cdot (fs1 / fc) = 0.09611636$   
 $2 = Asl\_com / (b \cdot d) \cdot (fs2 / fc) = 0.09611636$   
 $v = Asl\_mid / (b \cdot d) \cdot (fsv / fc) = 0.05866412$

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  $Mu2+$

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  $cu$ :  $cu^* = shear\_factor \cdot Max(cu, cc) = 0.00650345$   
 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) =  $(ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo\_1 = 340.00$   
 $ho\_1 = 610.00$   
 $bi2\_1 = 975400.00$   
 $ase2 = Max(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$   
 $psh\_min \cdot Fywe = Min(psh\_x \cdot Fywe, psh\_y \cdot Fywe) = 1.25908$

$psh\_x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 2.25223$   
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00261799$   
 $Ash1 = Astir\_1 * ns\_1 = 157.0796$   
 No stirups,  $ns\_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00062519$   
 $Ash2 = Astir\_2 * ns\_2 = 100.531$   
 No stirups,  $ns\_2 = 2.00$   
 $h2 = 500.00$

$psh\_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.25908$   
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00156298$   
 $Ash1 = Astir\_1 * ns\_1 = 157.0796$   
 No stirups,  $ns\_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00025008$   
 $Ash2 = Astir\_2 * ns\_2 = 100.531$   
 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:  $cc = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$

$y1 = 0.0025$   
 $sh1 = 0.008$   
 $ft1 = 833.34$   
 $fy1 = 694.45$   
 $su1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $Shear\_factor = 1.00$   
 $lo/lou, min = lb/ld = 1.00$

$su1 = 0.4 * esu1\_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,

For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered  
 characteristic value  $fsy1 = fs1 / 1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs1 = (fs\_jacket * Asl, ten, jacket + fs\_core * Asl, ten, core) / Asl, ten = 694.45$

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  
 $Shear\_factor = 1.00$   
 $lo/lou, min = lb/lb, min = 1.00$

$su2 = 0.4 * esu2\_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08$ ,

For calculation of  $esu2\_nominal$  and  $y2, sh2, ft2, fy2$ , it is considered  
 characteristic value  $fsy2 = fs2 / 1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs2 = (fs\_jacket * Asl, com, jacket + fs\_core * Asl, com, core) / Asl, com = 694.45$

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  
 $l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $yv$ ,  $shv$ ,  $ftv$ ,  $fyv$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y1$ ,  $sh1$ ,  $ft1$ ,  $fy1$ , are also multiplied by  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 694.45$   
 with  $Esv = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$   
 $1 = A_{sl,ten} / (b * d) * (fs1 / fc) = 0.08015524$   
 $2 = A_{sl,com} / (b * d) * (fs2 / fc) = 0.08015524$   
 $v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.04892233$

and confined core properties:

$b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = A_{sl,ten} / (b * d) * (fs1 / fc) = 0.09611636$   
 $2 = A_{sl,com} / (b * d) * (fs2 / fc) = 0.09611636$   
 $v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.05866412$

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  $l_b/l_d$

Adequate Lap Length:  $l_b/l_d \geq 1$

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  $cu$ :  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00650345$   
 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\*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,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)^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  $Min(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs\_jacket * Asl\_mid\_jacket + fs\_mid * Asl\_mid\_core) / Asl\_mid = 694.45$   
 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:

$b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = Asl\_ten / (b * d) * (fs1 / fc) = 0.09611636$   
 $2 = Asl\_com / (b * d) * (fs2 / fc) = 0.09611636$   
 $v = Asl\_mid / (b * d) * (fsv / fc) = 0.05866412$

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 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:

$$d2 = 160.00$$

$$A_v = 100530.965$$

$$f_y = 555.56$$

$$s = 300.00$$

Vs2 is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

$$V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$$

$$\text{From } (11-11), \text{ACI } 440: V_s + V_f \leq 818179.336$$

Calculation of Shear Strength at edge 2,  $V_{r2} = 383231.42$

$$V_{r2} = V_n ((22.5.1.1), \text{ACI } 318-14)$$

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f\*Vf'

where Vf is the contribution of FRPs (11.3), ACI 440).

$$\text{From Table } (22.5.5.1), \text{ACI } 318-14: V_c = 197061.477$$

$$= 1 \text{ (normal-weight concrete)}$$

$$\text{Mean concrete strength: } f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 33.00, \text{ but } f'_c^{0.5} \leq 8.3 \text{ MPa } (22.5.3.1, \text{ACI } 318-14)$$

$$p_w = A_s / (b_w \cdot d) = 0.00331157$$

$$A_s \text{ (tension reinf.)} = 709.9999$$

$$b_w = 670.00$$

$$d = 320.00$$

$$V_u \cdot d / M_u < 1 = 0.00$$

$$M_u = 1.2266780\text{E-}011$$

$$V_u = 6.9721474\text{E-}015$$

$$\text{From } (11.5.4.8), \text{ACI } 318-14: V_{s1} + V_{s2} = 186169.943$$

Vs1 = 186169.943 is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

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:

$$d = 160.00$$

$$A_v = 100530.965$$

$$f_y = 555.56$$

$$s = 300.00$$

Vs2 is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

$$V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$$

$$\text{From } (11-11), \text{ACI } 440: V_s + V_f \leq 818179.336$$

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

$$\text{Knowledge Factor, } = 1.00$$

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 ( $l_b/l_d \geq 1$ )  
 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:  $As_t = 709.9999$   
   -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  $u_R = 1.0^* u = 0.03344037$   
 $u = y + p = 0.03344037$

- 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  $p_t = 0.00380895$   
 $p_c = 0.00380895$   
 $p_v = 0.00232477$   
 $N = 3615.233$   
 $b = 670.00$   
 $" = 0.12044818$   
 $y_{comp} = 2.7622785E-005$   
 with  $f_c = 33.00$   
 $E_c = 26999.444$   
 $y = 0.22309813$   
 $A = 0.00990831$   
 $B = 0.00557012$   
 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:  $p = 0.03$

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,  $\gamma < 2$  (table 10-6, ASCE 41-17)  
 $= 9.9381411E-023$
- Stirrup Spacing  $\leq d/2$   
 $d = d_{external} = 357.00$   
 $s = s_{external} = 150.00$
- Strength provided by hoops  $V_s < 3/4 \times \text{design Shear}$   
 $V_s = 215957.134$ , already given in calculation of shear control ratio  
design Shear =  $5.6924552E-014$
- $(-)' / bal = -0.23508921$   
 $= A_{sl}/(b_w \cdot d) = 0.00296835$   
Tension Reinf Area:  $A_{sl} = 709.9999$   
 $' = A_{sc}/(b_w \cdot d) = 0.00697431$   
Compression Reinf Area:  $A_{sc} = 1668.186$
- From (B-1), ACI 318-11:  $bal = 0.01704017$   
 $f_c = (f_{c\_jacket} \cdot \text{Area}_{jacket} + f_{c\_core} \cdot \text{Area}_{core}) / \text{section\_area} = 33.00$   
 $f_y = f_{y\_jacket\_bars} = 555.56$   
From 10.2.7.3, ACI 318-11:  $\beta = 0.65$   
From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + \gamma) = 0.51922877$   
 $\gamma = 0.0027778$
- $V / (b_w \cdot d \cdot f_c^{0.5}) = 4.9891075E-019$ , 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

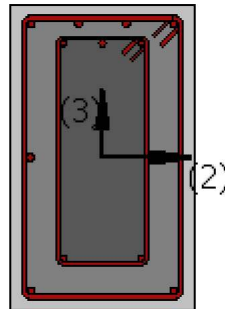
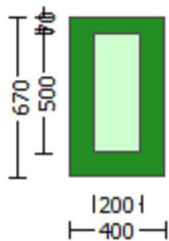
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

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  $135^\circ$ )

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,  $M_a = -1.0550018E-010$

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

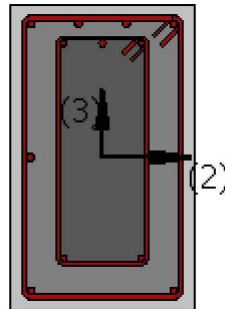
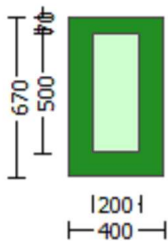
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (  $\phi$  )

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 ( $l_o/l_{ou}, \min \geq 1$ )  
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  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 506319.489$   
with  
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 7.4472E+008$   
 $\mu_{u1+} = 4.3734E+008$ , 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  
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 7.4472E+008$   
 $\mu_{u2+} = 4.3734E+008$ , 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
cc (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
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  
 $l_o/l_{o,min} = l_b/l_{b,min} = 1.00$   
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$   
 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  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 694.45$   
 with  $Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$   
 $y_v = 0.0025$   
 $sh_v = 0.008$   
 $ft_v = 833.34$   
 $fy_v = 694.45$   
 $suv = 0.032$   
 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  
 $l_o/l_{o,min} = l_b/l_d = 1.00$   
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 694.45$   
 with  $Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$   
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.05957415$   
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.10623177$   
 $v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.03374111$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.0736092$   
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.13125889$   
 $v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.04169017$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < v_{s,y2}$  - 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  $Mu_1$ -

Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:

$$u = 5.9367084E-005$$

$$Mu = 7.4472E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $\phi (5A.5, TBDY) = 0.002$   
 Final value of  $\phi$ :  $\phi^* = \text{shear\_factor} * \text{Max}(\phi, \phi_c) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $\phi = 0.00650345$   
 $\phi (5.4c) = 0.00563796$   
 $\phi (5.4d), TBDY = (\phi_1 * A_{ext} + \phi_2 * A_{int}) / A_{sec} = 0.14776895$   
 $\phi_1 = 0.14776895$   
 $b_o_1 = 340.00$   
 $h_o_1 = 610.00$   
 $b_{i2_1} = 975400.00$   
 $\phi_2 = \text{Max}(\phi_1, \phi_2) = 0.14776895$   
 $b_o_2 = 192.00$   
 $h_o_2 = 492.00$   
 $b_{i2_2} = 557856.00$   
 $\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.25908$

$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.25223$   
 $\phi_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 No stirups,  $n_{s\_1} = 2.00$   
 $h_1 = 670.00$   
 $\phi_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$   
 $A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$   
 No stirups,  $n_{s\_2} = 2.00$   
 $h_2 = 500.00$

$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.25908$   
 $\phi_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 No stirups,  $n_{s\_1} = 2.00$   
 $h_1 = 400.00$   
 $\phi_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$   
 $A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$   
 No stirups,  $n_{s\_2} = 2.00$   
 $h_2 = 200.00$

$A_{sec} = 268000.00$   
 $s_1 = 150.00$   
 $s_2 = 300.00$

$f_{ywe1} = 694.45$   
 $f_{ywe2} = 694.45$   
 $f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY:  $\phi_c = 0.00232446$   
 $\phi_c = \text{confinement factor} = 1.03245$

$y_1 = 0.0025$   
 $sh_1 = 0.008$   
 $ft_1 = 833.34$   
 $fy_1 = 694.45$   
 $su_1 = 0.032$

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  
 $\phi_o / \phi_{ou, \min} = \phi_b / \phi_d = 1.00$

$su_1 = 0.4 * \phi_{su1\_nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY:  $\phi_{su1\_nominal} = 0.08$ ,

For calculation of  $\phi_{su1\_nominal}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered  
 characteristic value  $f_{sy1} = f_{s1} / 1.2$ , from table 5.1, TBDY.

$y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 * (\phi_b / \phi_d)^{2/3})$ , 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  $E_{s1} = (E_{s, \text{jacket}} * A_{s1, \text{ten, jacket}} + E_{s, \text{core}} * A_{s1, \text{ten, core}}) / A_{s1, \text{ten}} = 200000.00$

$y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$

```

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,min = lb/lb,min = 1.00
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 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,min = lb/ld = 1.00
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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 lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 5.6088283E-005

$$\mu = 4.3734E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$\phi (5A.5, \text{TB DY}) = 0.002$$

$$\text{Final value of } \phi: \phi^* = \text{shear\_factor} * \text{Max}(\phi_c, \phi_s) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TB DY: } \phi_c = 0.00650345$$

$$\phi_s (5.4c) = 0.00563796$$

$$A_{se} ((5.4d), \text{TB DY}) = (A_{se1} * A_{ext} + A_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$A_{se1} = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i21} = 975400.00$$

$$A_{se2} = \text{Max}(A_{se1}, A_{se2}) = 0.14776895$$

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i22} = 557856.00$$

$$\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.25908$$

$$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.25223$$

$$\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.25908$$

$$\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TB DY), TB DY: } \phi_c = 0.00232446$$

$$\phi_c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

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

$$l_o / l_{o, \min} = l_b / l_d = 1.00$$

$$su_1 = 0.4 * esu_1_{\text{nominal}} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu_1_{\text{nominal}} = 0.08,$$

For calculation of  $esu_1_{\text{nominal}}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered  
characteristic value  $fsy_1 = fs_1 / 1.2$ , from table 5.1, TB DY.

$y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.

```

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 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 fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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/lb

Adequate Lap Length: lb/lb >= 1

Calculation of Mu2-

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:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$\alpha (5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.00650345$$

$$w_e (5.4c) = 0.00563796$$

$$a_{se} ((5.4d), \text{TBDY}) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$$

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25223$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25908$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$f_{t1} = 833.34$$

$$f_{y1} = 694.45$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$l_o / l_{ou, \min} = l_b / l_d = 1.00$$

$$su_1 = 0.4 * esu_1_{\text{nominal}} ((5.5), \text{TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu_1_{\text{nominal}} = 0.08,$$

For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered characteristic value  $fsy1 = fs1/1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs1 = (fs\_jacket \cdot Asl\_ten\_jacket + fs\_core \cdot Asl\_ten\_core) / Asl\_ten = 694.45$

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  $fsyv = fsv/1.2$ , 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) ' $V_w$ ' is replaced by ' $V_w + \phi V_f$ ' where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$

= 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

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / M_u < 1 = 1.00$

$M_u = 1.0197 \times 10^6$

$V_u = 9840.633$

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 ' $V_w + \phi V_f$ ' where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$

= 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

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / M_u < 1 = 1.00$

$M_u = 1.0197 \times 10^6$

$V_u = 9840.633$

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:  $Asl_{ten} = 911.0619$   
 -Compression:  $Asl_{com} = 911.0619$   
 -Middle:  $Asl_{mid} = 556.0619$

Calculation of Shear Capacity ratio ,  $Ve/V_r = 0.53480887$

Member Controlled by Flexure ( $Ve/V_r < 1$ )

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $Ve = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 204955.561$   
 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:

$u = 0.00010406$   
 $Mu = 3.0743E+008$

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:  $\phi_u = 0.00650345$

we (5.4c)  $= 0.00563796$

ase ((5.4d), TBDY)  $= (ase1 \cdot A_{ext} + ase2 \cdot A_{int})/A_{sec} = 0.14776895$

$ase1 = 0.14776895$   
 $bo_1 = 340.00$   
 $ho_1 = 610.00$   
 $bi2_1 = 975400.00$

$ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo_2 = 192.00$   
 $ho_2 = 492.00$   
 $bi2_2 = 557856.00$

$psh_{min} \cdot F_{ywe} = \text{Min}(psh_x \cdot F_{ywe}, psh_y \cdot F_{ywe}) = 1.25908$

$psh_x \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 2.25223$

$ps1$  (external)  $= (Ash1 \cdot h1/s1)/A_{sec} = 0.00261799$

$Ash1 = Astir_1 \cdot ns_1 = 157.0796$

No stirups,  $ns_1 = 2.00$

$h1 = 670.00$

$ps2$  (internal)  $= (Ash2 \cdot h2/s2)/A_{sec} = 0.00062519$

Ash2 = Astir\_2\*ns\_2 = 100.531  
 No stirups, ns\_2 = 2.00  
 h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
 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  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , 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  $f_{sv} = f_{sv}/1.2$ , 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  $f_{sv} = (f_{s,jacket} \cdot A_{sl,mid,jacket} + f_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 694.45$   
 with  $E_{sv} = (E_{s,jacket} \cdot A_{sl,mid,jacket} + E_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 200000.00$   
 $1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.08015524$   
 $2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.08015524$   
 $v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.04892233$

and confined core properties:

$b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $f_{cc} \text{ (5A.2, TBDY)} = 34.07073$   
 $cc \text{ (5A.5, TBDY)} = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.09611636$   
 $2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.09611636$   
 $v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.05866412$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

$v < v_{s,c}$  - RHS eq.(4.5) is satisfied

--->

$su \text{ (4.9)} = 0.13857861$   
 $Mu = MR_c \text{ (4.14)} = 3.0743E+008$   
 $u = su \text{ (4.1)} = 0.00010406$

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:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $co \text{ (5A.5, TBDY)} = 0.002$   
 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:  $cu = 0.00650345$   
 $we \text{ (5.4c)} = 0.00563796$   
 $ase \text{ ((5.4d), TBDY)} = (ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo_1 = 340.00$   
 $ho_1 = 610.00$   
 $bi2_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo_2 = 192.00$   
 $ho_2 = 492.00$   
 $bi2_2 = 557856.00$   
 $psh, \min \cdot F_{ywe} = \text{Min}(psh, x \cdot F_{ywe}, psh, y \cdot F_{ywe}) = 1.25908$

$psh, x \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 2.25223$   
 $ps1 \text{ (external)} = (A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} \cdot n_{s\_1} = 157.0796$

No stirups,  $ns_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00062519$   
 $Ash2 = Astir\_2 \cdot ns_2 = 100.531$   
 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.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  
 $Shear\_factor = 1.00$

$lo/lou, min = lb/ld = 1.00$

$su1 = 0.4 \cdot esu1\_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,

For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered  
 characteristic value  $fsy1 = fs1 / 1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs1 = (fs\_jacket \cdot Asl, ten, jacket + fs\_core \cdot Asl, ten, core) / Asl, ten = 694.45$

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  
 $Shear\_factor = 1.00$

$lo/lou, min = lb/lb, min = 1.00$

$su2 = 0.4 \cdot esu2\_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08$ ,

For calculation of  $esu2\_nominal$  and  $y2, sh2, ft2, fy2$ , it is considered  
 characteristic value  $fsy2 = fs2 / 1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs2 = (fs\_jacket \cdot Asl, com, jacket + fs\_core \cdot Asl, com, core) / Asl, com = 694.45$

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  
 $Shear\_factor = 1.00$

$lo/lou, min = lb/ld = 1.00$

$suv = 0.4 \cdot esuv\_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY:  $esuv\_nominal = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv\_nominal$  and  $yv, shv, ftv, fyv$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25 * (lb/ld)^{2/3})$ , 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:  $lb/ld \geq 1$

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) =  $(ase1 * Aext + ase2 * Aint) / Asec = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo\_1 = 340.00$   
 $ho\_1 = 610.00$   
 $bi2\_1 = 975400.00$   
 $ase2 = Max(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$   
 $psh\_min * Fywe = Min(psh\_x * Fywe, psh\_y * Fywe) = 1.25908$

$psh\_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25223$   
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00261799$   
 $Ash1 = Astir\_1 * ns\_1 = 157.0796$   
 No stirups,  $ns\_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00062519$   
 $Ash2 = Astir\_2 * ns\_2 = 100.531$   
 No stirups,  $ns\_2 = 2.00$   
 $h2 = 500.00$

$psh\_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25908$   
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00156298$   
 $Ash1 = Astir\_1 * ns\_1 = 157.0796$   
 No stirups,  $ns\_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00025008$   
 $Ash2 = Astir\_2 * ns\_2 = 100.531$   
 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:  $cc = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$

$y1 = 0.0025$   
 $sh1 = 0.008$   
 $ft1 = 833.34$   
 $fy1 = 694.45$   
 $su1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $Shear\_factor = 1.00$   
 $lo/lou, min = lb/ld = 1.00$

$su1 = 0.4 * esu1\_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,

For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered  
 characteristic value  $fsy1 = fs1 / 1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs1 = (fs\_jacket * Asl, ten, jacket + fs\_core * Asl, ten, core) / Asl, ten = 694.45$

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  
 $Shear\_factor = 1.00$   
 $lo/lou, min = lb/lb, min = 1.00$

$su2 = 0.4 * esu2\_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08$ ,

For calculation of  $esu2\_nominal$  and  $y2, sh2, ft2, fy2$ , it is considered  
 characteristic value  $fsy2 = fs2 / 1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs2 = (fs\_jacket * Asl, com, jacket + fs\_core * Asl, com, core) / Asl, com = 694.45$

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



$\text{Shear\_factor} = 1.00$   
 $\text{lo/lo}, \text{min} = \text{lb/ld} = 1.00$   
 $\text{su} = 0.4 * \text{esuv\_nominal} ((5.5), \text{TBDY}) = 0.032$   
 From table 5A.1, TBDY:  $\text{esuv\_nominal} = 0.08$ ,  
 considering characteristic value  $\text{fsy} = \text{fsv}/1.2$ , from table 5.1, TBDY  
 For calculation of  $\text{esuv\_nominal}$  and  $\text{yv}$ ,  $\text{shv}$ ,  $\text{ftv}$ ,  $\text{fyv}$ , it is considered  
 characteristic value  $\text{fsy} = \text{fsv}/1.2$ , from table 5.1, TBDY.  
 $\text{y1}$ ,  $\text{sh1}$ ,  $\text{ft1}$ ,  $\text{fy1}$ , are also multiplied by  $\text{Min}(1, 1.25 * (\text{lb/ld})^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $\text{fsv} = (\text{fs}_{\text{jacket}} * \text{Asl}_{\text{mid,jacket}} + \text{fs}_{\text{mid}} * \text{Asl}_{\text{mid,core}}) / \text{Asl}_{\text{mid}} = 694.45$   
 with  $\text{Esv} = (\text{Es}_{\text{jacket}} * \text{Asl}_{\text{mid,jacket}} + \text{Es}_{\text{mid}} * \text{Asl}_{\text{mid,core}}) / \text{Asl}_{\text{mid}} = 200000.00$   
 $1 = \text{Asl}_{\text{ten}} / (b * d) * (\text{fs1}/\text{fc}) = 0.08015524$   
 $2 = \text{Asl}_{\text{com}} / (b * d) * (\text{fs2}/\text{fc}) = 0.08015524$   
 $v = \text{Asl}_{\text{mid}} / (b * d) * (\text{fsv}/\text{fc}) = 0.04892233$

and confined core properties:

$b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $\text{fcc} (5A.2, \text{TBDY}) = 34.07073$   
 $\text{cc} (5A.5, \text{TBDY}) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = \text{Asl}_{\text{ten}} / (b * d) * (\text{fs1}/\text{fc}) = 0.09611636$   
 $2 = \text{Asl}_{\text{com}} / (b * d) * (\text{fs2}/\text{fc}) = 0.09611636$   
 $v = \text{Asl}_{\text{mid}} / (b * d) * (\text{fsv}/\text{fc}) = 0.05866412$

Case/Assumption: Unconfined full section - Steel rupture  
 ' does not satisfy Eq. (4.3)

--->  
 $v < v_{s,c}$  - RHS eq.(4.5) is satisfied  
 --->  
 $\text{su} (4.9) = 0.13857861$   
 $\text{Mu} = \text{MRc} (4.14) = 3.0743\text{E}+008$   
 $u = \text{su} (4.1) = 0.00010406$

Calculation of ratio  $\text{lb/ld}$

Adequate Lap Length:  $\text{lb/ld} \geq 1$

Calculation of  $\text{Mu2}$ -

Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:

$u = 0.00010406$   
 $\text{Mu} = 3.0743\text{E}+008$

with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $\text{fc} = 33.00$   
 $\text{co} (5A.5, \text{TBDY}) = 0.002$   
 Final value of  $\text{cu}$ :  $\text{cu}^* = \text{shear\_factor} * \text{Max}(\text{cu}, \text{cc}) = 0.00650345$   
 The  $\text{Shear\_factor}$  is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $\text{cu} = 0.00650345$   
 $\text{we} (5.4c) = 0.00563796$   
 $\text{ase} ((5.4d), \text{TBDY}) = (\text{ase1} * \text{Aext} + \text{ase2} * \text{Aint}) / \text{Asec} = 0.14776895$   
 $\text{ase1} = 0.14776895$   
 $\text{bo}_1 = 340.00$   
 $\text{ho}_1 = 610.00$   
 $\text{bi2}_1 = 975400.00$   
 $\text{ase2} = \text{Max}(\text{ase1}, \text{ase2}) = 0.14776895$   
 $\text{bo}_2 = 192.00$   
 $\text{ho}_2 = 492.00$

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,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  
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  $Min(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs\_jacket * Asl\_mid\_jacket + fs\_mid * Asl\_mid\_core) / Asl\_mid = 694.45$   
 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:

$b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = Asl\_ten / (b * d) * (fs1 / fc) = 0.09611636$   
 $2 = Asl\_com / (b * d) * (fs2 / fc) = 0.09611636$   
 $v = Asl\_mid / (b * d) * (fsv / fc) = 0.05866412$

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 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:

$$d2 = 160.00$$

$$A_v = 100530.965$$

$$f_y = 555.56$$

$$s = 300.00$$

Vs2 is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

$$V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$$

$$\text{From } (11-11), \text{ACI 440: } V_s + V_f \leq 818179.336$$

Calculation of Shear Strength at edge 2,  $V_{r2} = 383231.42$

$$V_{r2} = V_n ((22.5.1.1), \text{ACI 318-14})$$

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f\*Vf'

where Vf is the contribution of FRPs (11.3), ACI 440).

$$\text{From Table } (22.5.5.1), \text{ACI 318-14: } V_c = 197061.477$$

$$= 1 \text{ (normal-weight concrete)}$$

$$\text{Mean concrete strength: } f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 33.00, \text{ but } f'_c^{0.5} \leq 8.3 \text{ MPa } (22.5.3.1, \text{ACI 318-14})$$

$$p_w = A_s / (b_w \cdot d) = 0.00331157$$

$$A_s \text{ (tension reinf.)} = 709.9999$$

$$b_w = 670.00$$

$$d = 320.00$$

$$V_u \cdot d / M_u < 1 = 0.00$$

$$M_u = 1.2266780\text{E-}011$$

$$V_u = 6.9721474\text{E-}015$$

$$\text{From } (11.5.4.8), \text{ACI 318-14: } V_{s1} + V_{s2} = 186169.943$$

Vs1 = 186169.943 is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

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:

$$d = 160.00$$

$$A_v = 100530.965$$

$$f_y = 555.56$$

$$s = 300.00$$

Vs2 is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

$$V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$$

$$\text{From } (11-11), \text{ACI 440: } V_s + V_f \leq 818179.336$$

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

$$\text{Knowledge Factor, } = 1.00$$

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 ( $l_b/l_d \geq 1$ )  
 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:  $As_t = 709.9999$   
   -Compression:  $As_c = 1668.186$   
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $As_{t,ten} = 709.9999$   
   -Compression:  $As_{c,com} = 1266.062$   
   -Middle:  $As_{mid} = 402.1239$   
 Longitudinal External Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $As_{t,ten,jacket} = 402.1239$   
   -Compression:  $As_{c,com,jacket} = 804.2477$   
   -Middle:  $As_{mid,jacket} = 402.1239$   
 Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $As_{t,ten,core} = 307.8761$   
   -Compression:  $As_{c,com,core} = 461.8141$   
   -Middle:  $As_{mid,core} = 0.00$   
 Mean Diameter of Tension Reinforcement,  $Db_L = 15.00$

New component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u_R = 1.0^* u = 0.0507643$   
 $u = y + p = 0.0507643$

- Calculation of  $y$  -

$y = (M_y * L_s / 3) / E_{eff} = 0.0007643 ((4.29), \text{Biskinis Phd})$   
 $M_y = 2.7353E+008$   
 $L_s = M/V$  (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,  $\lambda / y < 2$  (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  $V_s < 3/4 \times \text{design Shear}$   
 $V_s = 386302.632$ , already given in calculation of shear control ratio  
design Shear = 15660.977
- ( - ')/ bal = -0.22420649  
=  $A_{sl}/(b_w \times d) = 0.00283094$   
Tension Reinf Area:  $A_{sl} = 709.9999$   
' =  $A_{slc}/(b_w \times d) = 0.00665146$   
Compression Reinf Area:  $A_{slc} = 1668.186$
- From (B-1), ACI 318-11: bal = 0.01704017  
fc =  $(f_{c\_jacket} \times \text{Area\_jacket} + f_{c\_core} \times \text{Area\_core}) / \text{section\_area} = 33.00$   
fy = fy\_jacket\_bars = 555.56  
From 10.2.7.3, ACI 318-11: 1 = 0.65  
From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + y) = 0.51922877$   
y = 0.0027778
- $V / (b_w \times d \times f_c^{0.5}) = 0.13090541$ , 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: (b)

## Calculation No. 15

beam B1, Floor 1

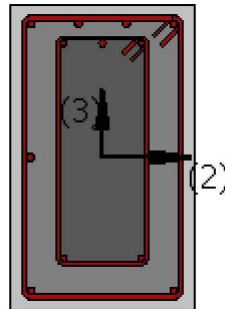
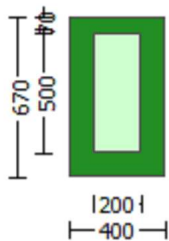
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity  $V_{Rd}$

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

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:  $As_{t,ten} = 709.9999$

-Compression:  $As_{c,com} = 1266.062$

-Middle:  $As_{mid} = 402.1239$

Mean Diameter of Tension Reinforcement,  $Db_{L,ten} = 15.00$

New component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $V_R = 1.0 \cdot V_n = 495183.483$   
 $V_n$  ((22.5.1.1), ACI 318-14) = 495183.483

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:  $V_c = 181024.218$   
= 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

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / M_u < 1 = 0.78742491$

$M_u = 1.0660E+007$

$V_u = 15660.977$

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

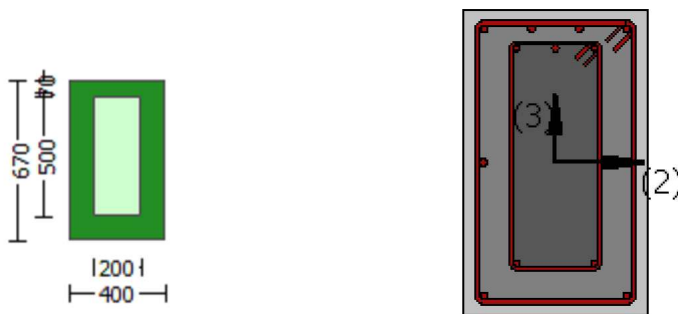
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity ( $\phi$ )

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 ( $l_o/l_{ou}, \min \geq 1$ )  
 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:  $As_t = 709.9999$   
   -Compression:  $As_c = 1668.186$   
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $As_{t,ten} = 709.9999$   
   -Compression:  $As_{c,com} = 1266.062$   
   -Middle:  $As_{l,mid} = 402.1239$

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  
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 7.4472E+008$   
 $\mu_{u1+} = 4.3734E+008$ , 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  
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 7.4472E+008$   
 $\mu_{u2+} = 4.3734E+008$ , 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:

$b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$

$f_c = 33.00$   
 $c_o (5A.5, TBDY) = 0.002$   
 Final value of  $c_u$ :  $c_u^* = \text{shear\_factor} * \text{Max}(c_u, c_o) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $c_u = 0.00650345$   
 $w_e (5.4c) = 0.00563796$   
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$   
 $a_{se1} = 0.14776895$   
 $b_o\_1 = 340.00$   
 $h_o\_1 = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$   
 $b_o\_2 = 192.00$   
 $h_o\_2 = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.25223$   
 $p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 No stirups,  $n_{s\_1} = 2.00$   
 $h_1 = 670.00$   
 $p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$   
 $A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$   
 No stirups,  $n_{s\_2} = 2.00$   
 $h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.25908$   
 $p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 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,  $n_{s\_2} = 2.00$   
 $h_2 = 200.00$

$A_{sec} = 268000.00$   
 $s_1 = 150.00$   
 $s_2 = 300.00$   
 $f_{ywe1} = 694.45$   
 $f_{ywe2} = 694.45$   
 $f_{ce} = 33.00$

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

$l_o / l_{ou, \min} = l_b / l_d = 1.00$

$su_1 = 0.4 * esu_{1\_nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY:  $esu_{1\_nominal} = 0.08$ ,

For calculation of  $esu_{1\_nominal}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered  
 characteristic value  $fsy_1 = fs_1 / 1.2$ , from table 5.1, TBDY.

$y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs_1 = (f_{s, \text{jacket}} * A_{sl, \text{ten, jacket}} + f_{s, \text{core}} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 694.45$

with  $Es_1 = (E_{s, \text{jacket}} * A_{sl, \text{ten, jacket}} + E_{s, \text{core}} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 200000.00$

$y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$   
 $fy_2 = 694.45$   
 $su_2 = 0.032$

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  
 $l_o/l_{o,min} = l_b/l_{b,min} = 1.00$   
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esu_{2,nominal} = 0.08$ ,  
 For calculation of  $esu_{2,nominal}$  and  $y_2, sh_2, ft_2, fy_2$ , it is considered  
 characteristic value  $fsy_2 = fs_2/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 694.45$   
 with  $Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$   
 $y_v = 0.0025$   
 $sh_v = 0.008$   
 $ft_v = 833.34$   
 $fy_v = 694.45$   
 $suv = 0.032$   
 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  
 $l_o/l_{o,min} = l_b/l_d = 1.00$   
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 694.45$   
 with  $Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$   
 $1 = A_{sl,ten} / (b * d) * (fs_1 / f_c) = 0.05957415$   
 $2 = A_{sl,com} / (b * d) * (fs_2 / f_c) = 0.10623177$   
 $v = A_{sl,mid} / (b * d) * (fsv / f_c) = 0.03374111$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = A_{sl,ten} / (b * d) * (fs_1 / f_c) = 0.0736092$   
 $2 = A_{sl,com} / (b * d) * (fs_2 / f_c) = 0.13125889$   
 $v = A_{sl,mid} / (b * d) * (fsv / f_c) = 0.04169017$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.09006517$   
 $Mu = MR_c (4.14) = 4.3734E+008$   
 $u = su (4.1) = 5.6088283E-005$

-----  
 Calculation of ratio  $l_b/l_d$   
 -----

Adequate Lap Length:  $l_b/l_d \geq 1$   
 -----  
 -----

-----  
 Calculation of  $Mu_1$ -  
 -----

-----  
 Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:

$u = 5.9367084E-005$

$Mu = 7.4472E+008$   
 -----

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $\phi (5A.5, TBDY) = 0.002$   
 Final value of  $\phi$ :  $\phi^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.00650345$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $\phi_u = 0.00650345$   
 $\phi_w (5.4c) = 0.00563796$   
 $\phi_{se} ((5.4d), TBDY) = (\phi_{se1} * A_{ext} + \phi_{se2} * A_{int}) / A_{sec} = 0.14776895$   
 $\phi_{se1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.25908$

$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.25223$   
 $\phi_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 No stirrups,  $n_{s\_1} = 2.00$   
 $h_1 = 670.00$   
 $\phi_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$   
 $A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$   
 No stirrups,  $n_{s\_2} = 2.00$   
 $h_2 = 500.00$

$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.25908$   
 $\phi_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 No stirrups,  $n_{s\_1} = 2.00$   
 $h_1 = 400.00$   
 $\phi_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$   
 $A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$   
 No stirrups,  $n_{s\_2} = 2.00$   
 $h_2 = 200.00$

$A_{sec} = 268000.00$   
 $s_1 = 150.00$   
 $s_2 = 300.00$

$f_{ywe1} = 694.45$   
 $f_{ywe2} = 694.45$   
 $f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY:  $\phi_c = 0.00232446$   
 $\phi_c = \text{confinement factor} = 1.03245$

$y_1 = 0.0025$   
 $sh_1 = 0.008$   
 $ft_1 = 833.34$   
 $fy_1 = 694.45$   
 $su_1 = 0.032$

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  
 $\phi_{lo/\phi_{ou, \min}} = \phi_b / \phi_d = 1.00$

$su_1 = 0.4 * \phi_{su1\_nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY:  $\phi_{su1\_nominal} = 0.08$ ,

For calculation of  $\phi_{su1\_nominal}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered  
 characteristic value  $f_{sy1} = f_{s1} / 1.2$ , from table 5.1, TBDY.

$y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 * (\phi_b / \phi_d)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $f_{s1} = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 694.45$

with  $E_{s1} = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$

$y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$

```

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,min = lb/lb,min = 1.00
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 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,min = lb/ld = 1.00
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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 lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:  
u = 5.6088283E-005

$$\mu = 4.3734E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$\phi (5A.5, \text{TB DY}) = 0.002$$

$$\text{Final value of } \phi: \phi^* = \text{shear\_factor} * \text{Max}(\phi, \phi_c) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TB DY: } \phi = 0.00650345$$

$$\phi (5.4c) = 0.00563796$$

$$\phi (5.4d), \text{TB DY} = (\phi_1 * A_{ext} + \phi_2 * A_{int}) / A_{sec} = 0.14776895$$

$$\phi_1 = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i21} = 975400.00$$

$$\phi_2 = \text{Max}(\phi_1, \phi_2) = 0.14776895$$

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i22} = 557856.00$$

$$\phi_{sh, \min} * \phi_{ywe} = \text{Min}(\phi_{sh, x} * \phi_{ywe}, \phi_{sh, y} * \phi_{ywe}) = 1.25908$$

$$\phi_{sh, x} * \phi_{ywe} = \phi_{sh1} * \phi_{ywe1} + \phi_{sh2} * \phi_{ywe2} = 2.25223$$

$$\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{sh, y} * \phi_{ywe} = \phi_{sh1} * \phi_{ywe1} + \phi_{sh2} * \phi_{ywe2} = 1.25908$$

$$\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$\phi_{ywe1} = 694.45$$

$$\phi_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TB DY), TB DY: } \phi_c = 0.00232446$$

$$\phi_c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor

and also multiplied by the shear\_factor according to 15.7.1.4, with

$$\text{Shear\_factor} = 1.00$$

$$l_o / l_{o, \min} = l_b / l_d = 1.00$$

$$su_1 = 0.4 * su_{1\_nominal} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } su_{1\_nominal} = 0.08,$$

For calculation of  $su_{1\_nominal}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered characteristic value  $fsy_1 = fs_1 / 1.2$ , from table 5.1, TB DY.

$y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.

```

with 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 fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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/lb

Adequate Lap Length: lb/lb >= 1

Calculation of Mu2-



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:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$\alpha (5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.00650345$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.00650345$$

$$w_e (5.4c) = 0.00563796$$

$$a_{se} ((5.4d), \text{TBDY}) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$$

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.25223$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.25908$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$f_{t1} = 833.34$$

$$f_{y1} = 694.45$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$l_o / l_{ou, \min} = l_b / l_d = 1.00$$

$$su_1 = 0.4 * esu_1_{\text{nominal}} ((5.5), \text{TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu_1_{\text{nominal}} = 0.08,$$

For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered characteristic value  $fsy1 = fs1/1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25*(lb/ld)^{2/3})$ , 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  $Min(1, 1.25*(lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45$

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  $Min(1, 1.25*(lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45$

with  $Es_v = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$

$1 = Asl,ten/(b*d)*(fs1/fc) = 0.10623177$   
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.05957415$   
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.03374111$

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  
 --->  
 $su (4.8) = 0.1403202$   
 $Mu = MRc (4.15) = 7.4472E+008$   
 $u = su (4.1) = 5.9367084E-005$

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 ' $V_w + f^*V_f$ ' where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$

= 1 (normal-weight concrete)

Mean concrete strength:  $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 33.00$ , but  $f_c'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$p_w = A_s / (b_w \cdot d) = 0.00331157$

$A_s$  (tension reinf.) = 709.9999

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / \mu_u < 1 = 1.00$

$\mu_u = 1.0197 \times 10^6$

$V_u = 9840.633$

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 ' $V_w + f^*V_f$ ' where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$

= 1 (normal-weight concrete)

Mean concrete strength:  $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 33.00$ , but  $f_c'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$p_w = A_s / (b_w \cdot d) = 0.00331157$

$A_s$  (tension reinf.) = 709.9999

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / \mu_u < 1 = 1.00$

$\mu_u = 1.0197 \times 10^6$

$V_u = 9840.633$

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/lo_u,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:  $Asl_{ten} = 911.0619$   
 -Compression:  $Asl_{com} = 911.0619$   
 -Middle:  $Asl_{mid} = 556.0619$

Calculation of Shear Capacity ratio ,  $Ve/V_r = 0.53480887$

Member Controlled by Flexure ( $Ve/V_r < 1$ )

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $Ve = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n / 2 = 204955.561$   
 with

$M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 3.0743E+008$

$\mu_{u1+} = 3.0743E+008$ , 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

$\mu_{u1-} = 3.0743E+008$ , 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

$M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 3.0743E+008$

$\mu_{u2+} = 3.0743E+008$ , 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

$\mu_{u2-} = 3.0743E+008$ , 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  $\mu_{u1+}$

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:  $\phi_u = 0.00650345$

we (5.4c)  $= 0.00563796$

$\phi_{se} ((5.4d), TBDY) = (\phi_{se1} \cdot A_{ext} + \phi_{se2} \cdot A_{int}) / A_{sec} = 0.14776895$

$\phi_{se1} = 0.14776895$

$b_{o\_1} = 340.00$

$h_{o\_1} = 610.00$

$b_{i2\_1} = 975400.00$

$\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$

$b_{o\_2} = 192.00$

$h_{o\_2} = 492.00$

$b_{i2\_2} = 557856.00$

$p_{sh,min} \cdot F_{ywe} = \text{Min}(p_{sh,x} \cdot F_{ywe}, p_{sh,y} \cdot F_{ywe}) = 1.25908$

$p_{sh,x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{sh2} \cdot F_{ywe2} = 2.25223$

$p_{s1} \text{ (external)} = (A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir\_1} \cdot n_{s\_1} = 157.0796$

No stirups,  $n_{s\_1} = 2.00$

$h_1 = 670.00$

$p_{s2} \text{ (internal)} = (A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00062519$

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  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , 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  $f_{sv} = f_{sv}/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 694.45$   
 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:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $f_{cc} \text{ (5A.2, TBDY)} = 34.07073$   
 $cc \text{ (5A.5, TBDY)} = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.09611636$   
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.09611636$   
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.05866412$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' does not satisfy Eq. (4.3)  
 --->  
 $v < v_{s,c}$  - RHS eq.(4.5) is satisfied  
 --->  
 $su \text{ (4.9)} = 0.13857861$   
 $Mu = MR_c \text{ (4.14)} = 3.0743E+008$   
 $u = su \text{ (4.1)} = 0.00010406$

-----  
 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:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $co \text{ (5A.5, TBDY)} = 0.002$   
 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:  $cu = 0.00650345$   
 $w_e \text{ (5.4c)} = 0.00563796$   
 $ase \text{ ((5.4d), TBDY)} = (ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo_1 = 340.00$   
 $ho_1 = 610.00$   
 $bi2_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo_2 = 192.00$   
 $ho_2 = 492.00$   
 $bi2_2 = 557856.00$   
 $psh_{min} \cdot F_{ywe} = \text{Min}(psh_x \cdot F_{ywe}, psh_y \cdot F_{ywe}) = 1.25908$   
 -----  
 $psh_x \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 2.25223$   
 $ps1 \text{ (external)} = (A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} \cdot n_{s\_1} = 157.0796$

No stirups,  $ns_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00062519$   
 $Ash2 = Astir\_2 \cdot ns_2 = 100.531$   
 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.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  
 $Shear\_factor = 1.00$

$lo/lou, min = lb/ld = 1.00$

$su1 = 0.4 \cdot esu1\_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,

For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered  
 characteristic value  $fsy1 = fs1/1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs1 = (fs,jacket \cdot Asl,ten,jacket + fs,core \cdot Asl,ten,core) / Asl,ten = 694.45$

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  
 $Shear\_factor = 1.00$

$lo/lou, min = lb/lb, min = 1.00$

$su2 = 0.4 \cdot esu2\_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08$ ,

For calculation of  $esu2\_nominal$  and  $y2, sh2, ft2, fy2$ , it is considered  
 characteristic value  $fsy2 = fs2/1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs2 = (fs,jacket \cdot Asl,com,jacket + fs,core \cdot Asl,com,core) / Asl,com = 694.45$

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  
 $Shear\_factor = 1.00$

$lo/lou, min = lb/ld = 1.00$

$suv = 0.4 \cdot esuv\_nominal \text{ ((5.5), TBDY)} = 0.032$



From table 5A.1, TBDY:  $esuv\_nominal = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv\_nominal$  and  $yv, shv, ftv, fyv$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25 * (lb/ld)^{2/3})$ , 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:  $lb/ld \geq 1$

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) =  $(ase1 * Aext + ase2 * Aint) / Asec = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo\_1 = 340.00$   
 $ho\_1 = 610.00$   
 $bi2\_1 = 975400.00$   
 $ase2 = Max(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$   
 $psh, min * Fywe = Min(psh, x * Fywe, psh, y * Fywe) = 1.25908$

$psh\_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25223$   
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / A_{sec} = 0.00261799$   
 $Ash1 = Astir\_1 * ns\_1 = 157.0796$   
 No stirups,  $ns\_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / A_{sec} = 0.00062519$   
 $Ash2 = Astir\_2 * ns\_2 = 100.531$   
 No stirups,  $ns\_2 = 2.00$   
 $h2 = 500.00$

$psh\_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25908$   
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / A_{sec} = 0.00156298$   
 $Ash1 = Astir\_1 * ns\_1 = 157.0796$   
 No stirups,  $ns\_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / A_{sec} = 0.00025008$   
 $Ash2 = Astir\_2 * ns\_2 = 100.531$   
 No stirups,  $ns\_2 = 2.00$   
 $h2 = 200.00$

$A_{sec} = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$

$f_{ywe1} = 694.45$   
 $f_{ywe2} = 694.45$   
 $f_{ce} = 33.00$

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  
 $Shear\_factor = 1.00$   
 $lo/lou, min = lb/ld = 1.00$

$su1 = 0.4 * esu1\_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,

For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered  
 characteristic value  $fsy1 = fs1 / 1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs1 = (fs\_jacket * A_{sl, ten, jacket} + fs\_core * A_{sl, ten, core}) / A_{sl, ten} = 694.45$

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  
 $Shear\_factor = 1.00$   
 $lo/lou, min = lb/lb, min = 1.00$

$su2 = 0.4 * esu2\_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08$ ,

For calculation of  $esu2\_nominal$  and  $y2, sh2, ft2, fy2$ , it is considered  
 characteristic value  $fsy2 = fs2 / 1.2$ , from table 5.1, TBDY.

$y2, sh2, ft2, fy2$ , are also multiplied by  $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

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 = (fsjacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Esjacket*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 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 = 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,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  
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  $Min(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs\_jacket * Asl\_mid\_jacket + fs\_mid * Asl\_mid\_core) / Asl\_mid = 694.45$   
 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:

$b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 34.07073$   
 $cc (5A.5, TBDY) = 0.00232446$   
 $c = \text{confinement factor} = 1.03245$   
 $1 = Asl\_ten / (b * d) * (fs1 / fc) = 0.09611636$   
 $2 = Asl\_com / (b * d) * (fs2 / fc) = 0.09611636$   
 $v = Asl\_mid / (b * d) * (fsv / fc) = 0.05866412$

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 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:

$$d2 = 160.00$$

$$A_v = 100530.965$$

$$f_y = 555.56$$

$$s = 300.00$$

Vs2 is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

$$V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$$

$$\text{From } (11-11), \text{ACI } 440: V_s + V_f \leq 818179.336$$

Calculation of Shear Strength at edge 2,  $V_{r2} = 383231.42$

$$V_{r2} = V_n ((22.5.1.1), \text{ACI } 318-14)$$

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f\*Vf'

where Vf is the contribution of FRPs (11.3), ACI 440).

$$\text{From Table } (22.5.5.1), \text{ACI } 318-14: V_c = 197061.477$$

$$= 1 \text{ (normal-weight concrete)}$$

$$\text{Mean concrete strength: } f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 33.00, \text{ but } f'_c^{0.5} \leq 8.3 \text{ MPa } (22.5.3.1, \text{ACI } 318-14)$$

$$p_w = A_s / (b_w \cdot d) = 0.00331157$$

$$A_s \text{ (tension reinf.)} = 709.9999$$

$$b_w = 670.00$$

$$d = 320.00$$

$$V_u \cdot d / M_u < 1 = 0.00$$

$$M_u = 1.2266780\text{E-}011$$

$$V_u = 6.9721474\text{E-}015$$

$$\text{From } (11.5.4.8), \text{ACI } 318-14: V_{s1} + V_{s2} = 186169.943$$

Vs1 = 186169.943 is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

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:

$$d = 160.00$$

$$A_v = 100530.965$$

$$f_y = 555.56$$

$$s = 300.00$$

Vs2 is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

$$V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$$

$$\text{From } (11-11), \text{ACI } 440: V_s + V_f \leq 818179.336$$

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

$$\text{Knowledge Factor, } = 1.00$$

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 ( $l_b/l_d \geq 1$ )  
 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:  $As_t = 709.9999$   
   -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  $u_R = 1.0^* u = 0.03344037$   
 $u = y + p = 0.03344037$

- 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  $I_b/I_d$

Adequate Lap Length:  $I_b/I_d \geq 1$

- 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,  $\gamma < 2$  (table 10-6, ASCE 41-17)  
 $= 1.7139944E-022$
- Stirrup Spacing  $\leq d/2$   
 $d = d_{external} = 357.00$   
 $s = s_{external} = 150.00$
- Strength provided by hoops  $V_s < 3/4 \times \text{design Shear}$   
 $V_s = 215957.134$ , already given in calculation of shear control ratio  
design Shear =  $5.6924552E-014$
- $(\rho - \rho')/ \rho_{bal} = -0.23508921$   
 $= A_{st}/(b_w \cdot d) = 0.00296835$   
Tension Reinf Area:  $A_{st} = 709.9999$   
 $\rho' = A_{sc}/(b_w \cdot d) = 0.00697431$   
Compression Reinf Area:  $A_{sc} = 1668.186$
- From (B-1), ACI 318-11:  $\rho_{bal} = 0.01704017$   
 $fc = (fc_{jacket} \cdot Area_{jacket} + fc_{core} \cdot Area_{core}) / section\_area = 33.00$   
 $fy = fy_{jacket\_bars} = 555.56$   
From 10.2.7.3, ACI 318-11:  $\beta_1 = 0.65$   
From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000 / (87000 + fy) = cb/dt = 0.003 / (0.003 + \gamma) = 0.51922877$   
 $\gamma = 0.0027778$
- $V / (b_w \cdot d \cdot fc^{0.5}) = 4.9891075E-019$ , 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)