

# Detailed Member Calculations

**Units: N&mm**

**Regulation: ASCE 41-17**

## Calculation No. 1

beam B1, Floor 1

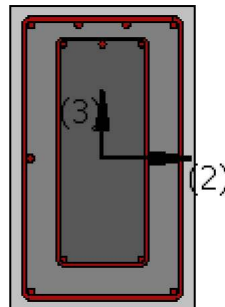
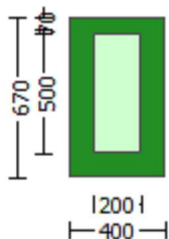
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity  $V_{Rd}$

Edge: Start

Local Axis: (2)



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

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 0.85$

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

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$   
Steel Elasticity,  $E_s = 200000.00$   
Existing Column  
New material of Secondary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$   
New material of Secondary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$   
Concrete Elasticity,  $E_c = 26999.444$   
Steel Elasticity,  $E_s = 200000.00$   
External Height,  $H = 670.00$   
External Width,  $W = 400.00$   
Internal Height,  $H = 500.00$   
Internal Width,  $W = 200.00$   
Cover Thickness,  $c = 25.00$   
Element Length,  $L = 3000.00$   
Secondary Member  
Ribbed Bars  
Ductile Steel  
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)  
Longitudinal Bars With Ends Lapped Starting at the End Sections  
Adequate Lap Length ( $l_o/l_{ou,min} = l_b/l_d \geq 1$ )  
No FRP Wrapping

#### Stepwise Properties

EDGE -A-  
Bending Moment,  $M_a = -3.9023745E-011$   
Shear Force,  $V_a = -2.4126677E-014$   
EDGE -B-  
Bending Moment,  $M_b = -3.3245903E-011$   
Shear Force,  $V_b = 2.4126677E-014$   
BOTH EDGES  
Axial Force,  $F = -3937.419$   
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  $V_R = 1.0 \cdot V_n = 339071.608$   
 $V_n ((22.5.1.1), \text{ACI } 318-14) = 339071.608$

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:  $f'_c = (f'_c\_jacket \cdot Area\_jacket + f'_c\_core \cdot Area\_core) / Area\_section = 25.00$ , but  $f'_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)  
 $p_w = As / (b_w \cdot d) = 0.00331157$   
 $As$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 3.9023745E-011$   
 $V_u = 2.4126677E-014$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 167551.608$   
 $V_{s1} = 167551.608$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 500.00$   
 $s = 150.00$

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

Vs2 = 0.00 is calculated for core, with:

$d = 160.00$

$A_v = 100530.965$

$f_y = 500.00$

$s = 300.00$

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

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

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

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

At local axis: 2

Integration Section: (a)

## Calculation No. 2

beam B1, Floor 1

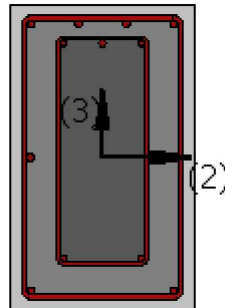
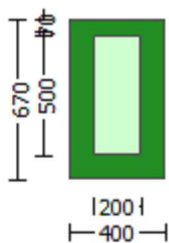
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (  $\theta$  )

Edge: Start

Local Axis: (2)



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

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\phi = 0.85$

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$   
 Existing Column  
 New material of Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$   
 New material of Secondary Member: Steel Strength,  $f_s = f_{sm} = 555.56$   
 Concrete Elasticity,  $E_c = 26999.444$   
 Steel Elasticity,  $E_s = 200000.00$   
 #####  
 Note: Especially for the calculation of moment strengths,  
 the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14  
 Jacket  
 New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$   
 Existing Column  
 New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$   
 #####  
 External Height,  $H = 670.00$   
 External Width,  $W = 400.00$   
 Internal Height,  $H = 500.00$   
 Internal Width,  $W = 200.00$   
 Cover Thickness,  $c = 25.00$   
 Mean Confinement Factor overall section = 1.00  
 Element Length,  $L = 3000.00$   
 Secondary Member  
 Ribbed Bars  
 Ductile Steel  
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)  
 Longitudinal Bars With Ends Lapped Starting at the End Sections  
 Adequate Lap Length ( $l_o/l_{ou}, \min \geq 1$ )  
 No FRP Wrapping

#### Stepwise Properties

At local axis: 3  
 EDGE -A-  
 Shear Force,  $V_a = 9840.632$   
 EDGE -B-  
 Shear Force,  $V_b = 9840.634$   
 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 = 9840.632, is the shear force acting at edge 1 for the the static loading combination  
V2 = 9840.634, 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:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_{co}) = 0.00514506$$

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

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

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

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

$$\phi_{ase1} = 0.14776895$$

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

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

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

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

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

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

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

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

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

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

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

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

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

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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) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    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

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

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:

$$u = 5.9367084E-005$$

$$\mu = 7.4472E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear\_factor} * \text{Max}(\mu, \alpha) = 0.00514506$$

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

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

$$\mu(5.4c) = 0.00169139$$

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

$$\alpha_1 = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i21} = 975400.00$$

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

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i22} = 557856.00$$

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

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

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

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

$$A_{sh1} = A_{stir\_1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$h_1 = 670.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s2} = 100.531$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$h_2 = 500.00$$

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

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

$$A_{sh1} = A_{stir\_1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$h_1 = 400.00$$

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

$$A_{sh2} = A_{stir\_2} * n_{s2} = 100.531$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$f_{ce} = 33.00$   
 From ((5A.5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $y_1 = 0.0025$   
 $sh_1 = 0.008$   
 $ft_1 = 833.34$   
 $fy_1 = 694.45$   
 $su_1 = 0.032$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $lo/lou, min = lb/ld = 1.00$   
 $su_1 = 0.4 * esu_1, nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esu_1, nominal = 0.08$ ,  
 For calculation of  $esu_1, nominal$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered  
 characteristic value  $fsy_1 = fs_1/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_1 = (fs, jacket * Asl, ten, jacket + fs, core * Asl, ten, core) / Asl, ten = 694.45$   
 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  
 $lo/lou, min = lb/lb, min = 1.00$   
 $su_2 = 0.4 * esu_2, nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esu_2, nominal = 0.08$ ,  
 For calculation of  $esu_2, nominal$  and  $y_2, sh_2, ft_2, fy_2$ , it is considered  
 characteristic value  $fsy_2 = fs_2/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_2 = (fs, jacket * Asl, com, jacket + fs, core * Asl, com, core) / Asl, com = 694.45$   
 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  
 $lo/lou, min = lb/ld = 1.00$   
 $suv = 0.4 * esuv, nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv, nominal = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv, nominal$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs, jacket * Asl, mid, jacket + fs, mid * Asl, mid, core) / Asl, mid = 694.45$   
 with  $Es_v = (Es, jacket * Asl, mid, jacket + Es, mid * Asl, mid, core) / Asl, mid = 200000.00$   
 $1 = Asl, ten / (b * d) * (fs_1 / f_c) = 0.10623177$   
 $2 = Asl, com / (b * d) * (fs_2 / f_c) = 0.05957415$   
 $v = Asl, mid / (b * d) * (fsv / f_c) = 0.03374111$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl, ten / (b * d) * (fs_1 / f_c) = 0.13125889$   
 $2 = Asl, com / (b * d) * (fs_2 / f_c) = 0.0736092$   
 $v = Asl, mid / (b * d) * (fsv / f_c) = 0.04169017$   
 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: lb/d >= 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
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00514506
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00514506
we (5.4c) = 0.00169139
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.25908
Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

```

```

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25223
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

```

```

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25908
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00

```

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From } ((5.5), \text{TBDY}), \text{TBDY: } c = 0.002$$

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

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 833.34$$

$$fy1 = 694.45$$

$$su1 = 0.032$$

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

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

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

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

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

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

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

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

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 833.34$$

$$fy2 = 694.45$$

$$su2 = 0.032$$

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

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

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

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

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 833.34$$

$$fyv = 694.45$$

$$suv = 0.032$$

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

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

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

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

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

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

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

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

$$1 = Asl, \text{ten} / (b * d) * (fs1 / fc) = 0.05957415$$

$$2 = Asl, \text{com} / (b * d) * (fs2 / fc) = 0.10623177$$

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

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, \text{TBDY}) = 33.00$$

$cc(5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.0736092$   
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.13125889$   
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.04169017$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)

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

$su(4.9) = 0.09006517$   
 $Mu = MRc(4.14) = 4.3734E+008$   
 $u = su(4.1) = 5.6088283E-005$

Calculation of ratio  $l_b/l_d$

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

Calculation of  $Mu_2$ -

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

$u = 5.9367084E-005$   
 $Mu = 7.4472E+008$

with full section properties:

$b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$   
 $fc = 33.00$   
 $co(5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00514506$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00514506$   
 $we(5.4c) = 0.00169139$   
 $ase((5.4d), TBDY) = (ase1*A_{ext} + ase2*A_{int})/A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo_1 = 340.00$   
 $ho_1 = 610.00$   
 $bi2_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo_2 = 192.00$   
 $ho_2 = 492.00$   
 $bi2_2 = 557856.00$   
 $psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.25908$   
 Expression ((5.4d), TBDY) for  $psh,min*Fywe$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.25223$   
 $ps1(\text{external}) = (A_{sh1}*h1/s1)/A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1}*ns_1 = 157.0796$   
 No stirrups,  $ns_1 = 2.00$   
 $h1 = 670.00$   
 $ps2(\text{internal}) = (A_{sh2}*h2/s2)/A_{sec} = 0.00062519$   
 $A_{sh2} = A_{stir\_2}*ns_2 = 100.531$   
 No stirrups,  $ns_2 = 2.00$   
 $h2 = 500.00$

$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.25908$   
 $ps1(\text{external}) = (A_{sh1}*h1/s1)/A_{sec} = 0.00156298$   
 $A_{sh1} = A_{stir\_1}*ns_1 = 157.0796$

No stirrups,  $ns_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$   
 $Ash2 = Astir\_2 \cdot ns\_2 = 100.531$   
 No stirrups,  $ns_2 = 2.00$   
 $h2 = 200.00$

-----  
 $Asec = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fyw1 = 694.45$   
 $fyw2 = 694.45$   
 $fce = 33.00$

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

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

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

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

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

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  $fs1 = (fs\_jacket \cdot Asl, \text{ten}, \text{jacket} + fs\_core \cdot Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 694.45$

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

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

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

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

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

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

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

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

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

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

$yv = 0.0025$   
 $shv = 0.008$   
 $ftv = 833.34$   
 $fyv = 694.45$   
 $suv = 0.032$

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

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

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

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

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

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

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

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

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

$1 = Asl, \text{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.10623177$

$2 = Asl, \text{com} / (b \cdot d) \cdot (fs2 / fc) = 0.05957415$

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

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

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

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

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

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.13125889$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.0736092$$

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

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  $l_b/d$

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

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

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

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

$$b_w = 400.00$$

$$d = 536.00$$

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

$$M_u = 1.0197E+006$$

$$V_u = 9840.632$$

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

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

$$d = 536.00$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

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

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

$$d_2 = 400.00$$

$$A_v = 100530.965$$

$$f_y = 555.56$$

$$s = 300.00$$

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

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

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

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

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

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

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

From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot Area\_jacket + f'_{c\_core} \cdot Area\_core) / Area\_section = 33.00$ , but  $f_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / M_u < 1 = 1.00$   
 $M_u = 1.0197E+006$   
 $V_u = 9840.634$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 349068.643$   
 $V_{s1} = 311834.654$  is calculated for jacket, with:  
 $d = 536.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 37233.989$  is calculated for jacket, with:  
 $d = 400.00$   
 $A_v = 100530.965$   
 $f_y = 555.56$   
 $s = 300.00$   
 $V_{s2}$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)  
 $2(1-s/d) = 0.50$   
 $V_f$  ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

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

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

Constant Properties

Knowledge Factor,  $\phi = 0.85$   
Mean strength values are used for both shear and moment calculations.  
Consequently:  
Jacket  
New material of Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$   
New material of Secondary 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 Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$   
New material of Secondary Member: Steel Strength,  $f_s = f_{sm} = 555.56$   
Concrete Elasticity,  $E_c = 26999.444$   
Steel Elasticity,  $E_s = 200000.00$   
#####  
Note: Especially for the calculation of moment strengths,  
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14  
Jacket  
New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$   
Existing Column  
New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$   
#####  
External Height,  $H = 670.00$

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

#### Stepwise Properties

At local axis: 2  
 EDGE -A-  
 Shear Force,  $V_a = 1.8202823E-014$   
 EDGE -B-  
 Shear Force,  $V_b = -1.8202823E-014$   
 BOTH EDGES  
 Axial Force,  $F = -2237.255$   
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
   -Tension:  $As_t = 709.9999$   
   -Compression:  $As_c = 1668.186$   
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $As_{t,ten} = 911.0619$   
   -Compression:  $As_{c,com} = 911.0619$   
   -Middle:  $As_{l,mid} = 556.0619$

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  
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 3.0743E+008$   
 $\mu_{u1+} = 3.0743E+008$ , 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 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 static loading combination  
 and  
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$   
 with  
 $V_1 = 1.8202823E-014$ , is the shear force acting at edge 1 for the static loading combination  
 $V_2 = -1.8202823E-014$ , 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:

$\phi_u = 0.00010406$   
 $\mu_u = 3.0743E+008$

with full section properties:

$b = 670.00$   
 $d = 357.00$

$d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $fc = 33.00$   
 $co (5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = shear\_factor * Max(cu, cc) = 0.00514506$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00514506$   
 $we (5.4c) = 0.00169139$   
 $ase ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo_1 = 340.00$   
 $ho_1 = 610.00$   
 $bi2_1 = 975400.00$   
 $ase2 = Max(ase1, ase2) = 0.14776895$   
 $bo_2 = 192.00$   
 $ho_2 = 492.00$   
 $bi2_2 = 557856.00$   
 $psh, min * F_{ywe} = Min(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.25908$   
 Expression ((5.4d), TBDY) for  $psh, min * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

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

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

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

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

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

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/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) = 0.08015524
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) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
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:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi: \phi^* = \text{shear\_factor} * \text{Max}(\phi_c, \phi_s) = 0.00514506$$

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

$$\text{From (5.4b), TB DY: } \phi_c = 0.00514506$$

$$\phi_s (5.4c) = 0.00169139$$

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

$$\phi_{se1} = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i21} = 975400.00$$

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

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i22} = 557856.00$$

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

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

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

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

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

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

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

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

$$su_1 = 0.4 * esu_{1\_nominal} ((5.5), \text{TB DY}) = 0.032$$

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

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

characteristic value  $fsy1 = fs1/1.2$ , 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  
 $lo/lou, min = lb/lb, min = 1.00$   
 $su2 = 0.4 \cdot esu2_{nominal} ((5.5), TBDY) = 0.032$   
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  
 $lo/lou, min = lb/ld = 1.00$   
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$   
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  $Es_v = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$   
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.08015524$   
 $2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.08015524$   
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.04892233$   
and confined core properties:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.09611636$   
 $2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.09611636$   
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.05866412$   
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  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

$$\phi_u = 0.00010406$$

$$\mu = 3.0743E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

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

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

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

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

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

$$\phi_{ase1} = 0.14776895$$

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

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

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

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

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

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

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

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

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

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

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

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

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

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/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) = 0.08015524
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) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
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/lb

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

Calculation of  $\mu_2$ -

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

$$\mu = 0.00010406$$

$$\mu = 3.0743E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

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

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

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

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

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

$$a_{se1} = 0.14776895$$

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

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

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

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

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

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

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

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

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

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

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

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

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

```

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) = 0.08015524
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) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    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

```

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

Calculation of ratio  $l_b/d$

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

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

From Table (22.5.5.1), ACI 318-14:  $V_c = 197061.477$   
 $= 1$  (normal-weight concrete)  
 Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot \text{Area}_{jacket} + f'_{c\_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$ , 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  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 4.0861879E-011$   
 $V_u = 1.8202823E-014$   
 From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$   
 $V_{s1} = 186169.943$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17, 10.3.4)  
 $V_{s2} = 0.00$  is calculated for jacket, with:  
 $d_2 = 160.00$   
 $A_v = 100530.965$   
 $f_y = 555.56$   
 $s = 300.00$   
 $V_{s2}$  is considered 0 ( $s > d$ , according to ASCE 41-17, 10.3.4)  
 $V_f$  ((11-3)-(11.4), ACI 440) = 0.00  
 From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

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

NOTE: In expression (22.5.1.1) ' $V_w$ ' is replaced by ' $V_w + f^*V_f$ '  
 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  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 1.3749363E-011$   
 $V_u = 1.8202823E-014$   
 From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$   
 $V_{s1} = 186169.943$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$



s = 150.00

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

Vs2 = 0.00 is calculated for jacket, with:

d = 160.00

Av = 100530.965

fy = 555.56

s = 300.00

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

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

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

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

At local axis: 2

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

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 0.85$

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

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

Consequently:

Jacket

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

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

New material of Secondary 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,  $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

Bending Moment,  $M = 8.6307E+006$

Shear Force,  $V_2 = -2.4126677E-014$

Shear Force,  $V_3 = 2658.348$

Axial Force,  $F = -3937.419$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $As_t = 709.9999$

-Compression:  $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

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

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

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

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension:  $Asl_{ten,jacket} = 402.1239$   
-Compression:  $Asl_{com,jacket} = 804.2477$   
-Middle:  $Asl_{mid,jacket} = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $Asl_{ten,core} = 307.8761$   
-Compression:  $Asl_{com,core} = 461.8141$   
-Middle:  $Asl_{mid,core} = 0.00$

Mean Diameter of Tension Reinforcement,  $DbL = 15.00$

New component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u_R = 1.0^*$   $u = 0.01364658$   
 $u = y + p = 0.01364658$

- Calculation of  $y$  -

$y = (My * Ls / 3) / Eleff = 0.00364658$  ((4.29), Biskinis Phd))  
 $My = 2.7362E+008$   
 $Ls = M/V$  (with  $Ls > 0.1 * L$  and  $Ls < 2 * L$ ) = 3246.643  
From table 10.5, ASCE 41\_17:  $Eleff = 0.3 * Ec * Ig = 8.1204E+013$

Calculation of Yielding Moment  $My$

Calculation of  $y$  and  $My$  according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$   
 $y_{ten} = 5.4344943E-006$   
with  $fy = 555.56$   
 $d = 627.00$   
 $y = 0.184781$   
 $A = 0.00951066$   
 $B = 0.00406206$   
with  $pt = 0.00283094$   
 $pc = 0.00504809$   
 $pv = 0.00160336$   
 $N = 3937.419$   
 $b = 400.00$   
 $" = 0.06858054$   
 $y_{comp} = 1.9038515E-005$   
with  $fc = 33.00$   
 $Ec = 26999.444$   
 $y = 0.18430241$   
 $A = 0.00944672$   
 $B = 0.0040338$   
with  $Es = 200000.00$

Calculation of ratio  $lb/ld$

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

- Calculation of  $p$  -

From table 10-7:  $p = 0.01$

with:

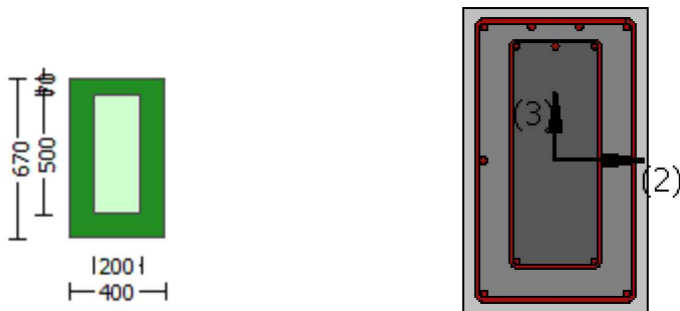
- Condition i occurred  
Beam controlled by flexure:  $Vp/Vo \leq 1$   
shear control ratio  $Vp/Vo = 0.90705729$
- Transverse Reinforcement: C
- Stirrup Spacing  $\leq d/3$
- Low ductility demand,  $y < 2$  (table 10-6, ASCE 41-17)  
 $= 5.3349993E-005$

- Stirrup Spacing  $\leq d/2$   
 $d = d_{\text{external}} = 627.00$   
 $s = s_{\text{external}} = 150.00$
- Strength provided by hoops  $V_s < 3/4 \cdot \text{design Shear}$   
 $V_s = 386302.632$ , already given in calculation of shear control ratio  
 $\text{design Shear} = 2658.348$
- $(\rho - \rho') / \rho_{\text{bal}} = -0.22420649$   
 $\rho = A_{\text{st}} / (b_w \cdot d) = 0.00283094$   
 $\rho' = A_{\text{sc}} / (b_w \cdot d) = 0.00665146$   
 $\text{Compression Reinf Area: } A_{\text{sc}} = 1668.186$   
 $\text{From (B-1), ACI 318-11: } \rho_{\text{bal}} = 0.01704017$   
 $\rho_c = (\rho_c \cdot \text{jacket} \cdot \text{Area}_{\text{jacket}} + \rho_c \cdot \text{core} \cdot \text{Area}_{\text{core}}) / \text{section\_area} = 33.00$   
 $\rho_y = \rho_y \cdot \text{jacket\_bars} = 555.56$   
 $\text{From 10.2.7.3, ACI 318-11: } \rho_1 = 0.65$   
 $\text{From fig R10.3.3, ACI 318-11 (Ence 454, too): } 87000 / (87000 + \rho_y) = c_b / d_t = 0.003 / (0.003 + \rho_y) = 0.51922877$   
 $\rho_y = 0.0027778$
- $V / (b_w \cdot d \cdot \rho_c^{0.5}) = 0.02222033$ , NOTE: units in lb & in  
 $b_w = 400.00$

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

### Calculation No. 3

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



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

Integration Section: (a)

Section Type: rcjars

### Constant Properties

Knowledge Factor,  $\phi = 0.85$

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

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

### Stepwise Properties

EDGE -A-

Bending Moment,  $M_a = 8.6307E+006$

Shear Force,  $V_a = 2658.348$

EDGE -B-

Bending Moment,  $M_b = 1.2916E+007$

Shear Force,  $V_b = 17022.918$

BOTH EDGES

Axial Force,  $F = -3937.419$

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  $V_R = 1.0 \cdot V_n = 487671.945$

$V_n$  ((22.5.1.1), ACI 318-14) = 487671.945

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:  $V_c = 173512.68$

= 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

$V_u \cdot d / M_u < 1 = 0.16509363$

$M_u$  = 8.6307E+006

$V_u$  = 2658.348

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

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

$d = 536.00$

$A_v = 157079.633$

$f_y = 500.00$

$s = 150.00$

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

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

$d = 400.00$

$A_v = 100530.965$

$f_y = 500.00$

$s = 300.00$

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

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

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

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

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

At local axis: 3

Integration Section: (a)

## Calculation No. 4

beam B1, Floor 1

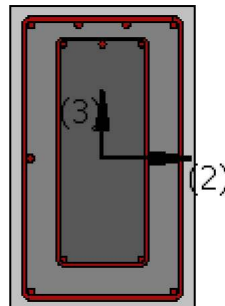
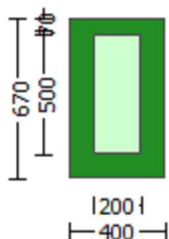
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (  $\mu$  )

Edge: Start

Local Axis: (3)



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

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

### Constant Properties

Knowledge Factor,  $\gamma = 0.85$

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

Consequently:

Jacket

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

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

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

Jacket

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

Existing Column

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

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length,  $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

### Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force,  $V_a = 9840.632$

EDGE -B-

Shear Force,  $V_b = 9840.634$

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

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

Mu1+ = 4.3734E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

Mu1- = 7.4472E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

Mpr2 = Max(Mu2+ , Mu2-) = 7.4472E+008

Mu2+ = 4.3734E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

Mu2- = 7.4472E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

and

$\pm v_u \cdot l_n = (|V1| + |V2|)/2$

with

V1 = 9840.632, is the shear force acting at edge 1 for the the static loading combination

V2 = 9840.634, 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

$\nu = 0.00027032$

N = 2237.255

f<sub>c</sub> = 33.00

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

Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} \cdot \text{Max}(\phi_u, \phi_{co}) = 0.00514506$

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

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

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

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

$\phi_{ase1} = 0.14776895$

$\phi_{bo\_1} = 340.00$

$\phi_{ho\_1} = 610.00$

$\phi_{bi2\_1} = 975400.00$

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

$\phi_{bo\_2} = 192.00$

$\phi_{ho\_2} = 492.00$

$\phi_{bi2\_2} = 557856.00$

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

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

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

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

$\phi_{Ash1} = \phi_{Astir\_1} \cdot n_{s\_1} = 157.0796$

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

$h1 = 670.00$

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

$\phi_{Ash2} = \phi_{Astir\_2} \cdot n_{s\_2} = 100.531$

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

$h2 = 500.00$   
-----

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

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

$\phi_{Ash1} = \phi_{Astir\_1} \cdot n_{s\_1} = 157.0796$

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

$h1 = 400.00$

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

$\phi_{Ash2} = \phi_{Astir\_2} \cdot n_{s\_2} = 100.531$

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

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From } ((5.5), \text{TB DY}), \text{TB DY: } c c = 0.002$$

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

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 833.34$$

$$fy1 = 694.45$$

$$su1 = 0.032$$

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

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

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

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

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

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

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

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

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 833.34$$

$$fy2 = 694.45$$

$$su2 = 0.032$$

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

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

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

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

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

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

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

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

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 833.34$$

$$fyv = 694.45$$

$$suv = 0.032$$

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

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

$$suv = 0.4 * esuv\_nominal ((5.5), \text{TB DY}) = 0.032$$

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

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

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

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

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

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

$$1 = Asl, \text{ten} / (b * d) * (fs1 / fc) = 0.05957415$$

$$2 = Asl, \text{com} / (b * d) * (fs2 / fc) = 0.10623177$$

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

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, \text{TB DY}) = 33.00$$



$cc(5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.0736092$   
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.13125889$   
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.04169017$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)

--->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is 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  $Mu1$ -

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

$u = 5.9367084E-005$   
 $Mu = 7.4472E+008$

with full section properties:

$b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $co(5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00514506$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00514506$   
 $we(5.4c) = 0.00169139$   
 $ase((5.4d), TBDY) = (ase1*A_{ext} + ase2*A_{int})/A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo_1 = 340.00$   
 $ho_1 = 610.00$   
 $bi2_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo_2 = 192.00$   
 $ho_2 = 492.00$   
 $bi2_2 = 557856.00$   
 $psh,min*F_{ywe} = \text{Min}(psh,x*F_{ywe}, psh,y*F_{ywe}) = 1.25908$   
 Expression ((5.4d), TBDY) for  $psh,min*F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh_x*F_{ywe} = psh1*F_{ywe1} + ps2*F_{ywe2} = 2.25223$   
 $ps1(\text{external}) = (A_{sh1}*h1/s1)/A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1}*ns_1 = 157.0796$   
 No stirrups,  $ns_1 = 2.00$   
 $h1 = 670.00$   
 $ps2(\text{internal}) = (A_{sh2}*h2/s2)/A_{sec} = 0.00062519$   
 $A_{sh2} = A_{stir\_2}*ns_2 = 100.531$   
 No stirrups,  $ns_2 = 2.00$   
 $h2 = 500.00$

$psh_y*F_{ywe} = psh1*F_{ywe1} + ps2*F_{ywe2} = 1.25908$   
 $ps1(\text{external}) = (A_{sh1}*h1/s1)/A_{sec} = 0.00156298$   
 $A_{sh1} = A_{stir\_1}*ns_1 = 157.0796$

No stirrups,  $ns_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$   
 $Ash2 = Astir\_2 \cdot ns\_2 = 100.531$   
 No stirrups,  $ns_2 = 2.00$   
 $h2 = 200.00$

-----  
 $Asec = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fyw1 = 694.45$   
 $fyw2 = 694.45$   
 $fce = 33.00$

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

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

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

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

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

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  $fs1 = (fs\_jacket \cdot Asl, \text{ten}, \text{jacket} + fs\_core \cdot Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 694.45$

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

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

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

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

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

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

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

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

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

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

$yv = 0.0025$   
 $shv = 0.008$   
 $ftv = 833.34$   
 $fyv = 694.45$   
 $suv = 0.032$

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

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

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

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

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

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

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

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

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

$1 = Asl, \text{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.10623177$

$2 = Asl, \text{com} / (b \cdot d) \cdot (fs2 / fc) = 0.05957415$

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

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

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

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

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

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.13125889$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.0736092$$

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

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

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

--->

$$s_u(4.8) = 0.1403202$$

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

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

Calculation of ratio  $l_b/d$

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

Calculation of  $Mu_{2+}$

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:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, cc) = 0.00514506$$

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

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

$$\phi_{ue}(5.4c) = 0.00169139$$

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

$$a_{se1} = 0.14776895$$

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

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

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

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

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

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

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

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

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

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

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

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

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

$$h_1 = 670.00$$

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

Ash2 = Astir\_2\*ns\_2 = 100.531  
 No stirups, ns\_2 = 2.00  
 h2 = 500.00

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

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

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

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 833.34

fy1 = 694.45

su1 = 0.032

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

lo/lou,min = lb/lb = 1.00

su1 = 0.4\*esu1\_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1\_nominal = 0.08,

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

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

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

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

yv = 0.0025

shv = 0.008

ftv = 833.34

fyv = 694.45

suv = 0.032

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

lo/lou,min = lb/lb = 1.00

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

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

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

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

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

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

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

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.05957415$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.10623177$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.03374111$

and confined core properties:

$b = 340.00$

$d = 597.00$

$d' = 13.00$

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

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

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

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.0736092$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.13125889$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.04169017$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su \text{ (4.9)} = 0.09006517$

$Mu = MR_c \text{ (4.14)} = 4.3734E+008$

$u = su \text{ (4.1)} = 5.6088283E-005$

-----

Calculation of ratio  $l_b/l_d$

-----

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

-----

Calculation of  $Mu_2$ -

-----

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

$u = 5.9367084E-005$

$Mu = 7.4472E+008$

-----

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.00027032$

$N = 2237.255$

$f_c = 33.00$

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

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

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

From (5.4b), TBDY:  $cu = 0.00514506$

we (5.4c) =  $0.00169139$

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

$ase1 = 0.14776895$

$bo_1 = 340.00$

$ho_1 = 610.00$

$bi2_1 = 975400.00$

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

$bo_2 = 192.00$

$ho_2 = 492.00$

$bi2_2 = 557856.00$

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

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

-----

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

$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00261799$   
 $Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$   
 No stirups,  $ns\_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00062519$   
 $Ash2 = Astir\_2 \cdot ns\_2 = 100.531$   
 No stirups,  $ns\_2 = 2.00$   
 $h2 = 500.00$

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

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

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

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

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  
 $Shear\_factor = 1.00$

$l_o/l_o, \min = l_b/d = 1.00$   
 $s_u = 0.4 * e_{suv\_nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $e_{suv\_nominal} = 0.08$ ,  
 considering characteristic value  $f_{syv} = f_{sv}/1.2$ , from table 5.1, TBDY  
 For calculation of  $e_{suv\_nominal}$  and  $y_v$ ,  $sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $f_{syv} = f_{sv}/1.2$ , from table 5.1, TBDY.  
 $y_1$ ,  $sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 * (l_b/d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 694.45$   
 with  $E_{sv} = (E_{s,jacket} * A_{s,mid,jacket} + E_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 200000.00$   
 $1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.10623177$   
 $2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.05957415$   
 $v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.03374111$

and confined core properties:

$b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.13125889$   
 $2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.0736092$   
 $v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.04169017$

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

--->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is not satisfied  
 --->  
 $v < v_{s,c}$  - RHS eq.(4.5) is satisfied  
 --->  
 $su (4.8) = 0.1403202$   
 $M_u = M_{Rc} (4.15) = 7.4472E+008$   
 $u = su (4.1) = 5.9367084E-005$

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,  $V_{r1} = 558200.119$   
 $V_{r1} = V_n ((22.5.1.1), \text{ACI } 318-14)$

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)  
 $p_w = A_s / (b_w * d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u * d / M_u < 1 = 1.00$   
 $M_u = 1.0197E+006$   
 $V_u = 9840.632$   
 From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 349068.643$   
 $V_{s1} = 311834.654$  is calculated for jacket, with:  
 $d = 536.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17, 10.3.4)

Vs2 = 37233.989 is calculated for jacket, with:

d2 = 400.00

Av = 100530.965

fy = 555.56

s = 300.00

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

2(1-s/d) = 0.50

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

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

Calculation of Shear Strength at edge 2, Vr2 = 558200.119

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

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

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

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

= 1 (normal-weight concrete)

Mean concrete strength: fc' = (fc'\_jacket\*Area\_jacket + fc'\_core\*Area\_core)/Area\_section = 33.00, but fc'^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)

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

As (tension reinf.) = 709.9999

bw = 400.00

d = 536.00

Vu\*d/Mu < 1 = 1.00

Mu = 1.0197E+006

Vu = 9840.634

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

Vs1 = 311834.654 is calculated for jacket, with:

d = 536.00

Av = 157079.633

fy = 555.56

s = 150.00

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

Vs2 = 37233.989 is calculated for jacket, with:

d = 400.00

Av = 100530.965

fy = 555.56

s = 300.00

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

2(1-s/d) = 0.50

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

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

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

At local axis: 3

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

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

Knowledge Factor, = 0.85

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

Consequently:

Jacket

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

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

Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00

Existing Column

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



New material of Secondary Member: Steel Strength,  $f_s = f_{sm} = 555.56$   
Concrete Elasticity,  $E_c = 26999.444$   
Steel Elasticity,  $E_s = 200000.00$   
#####  
Note: Especially for the calculation of moment strengths,  
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14  
Jacket  
New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$   
Existing Column  
New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$   
#####  
External Height,  $H = 670.00$   
External Width,  $W = 400.00$   
Internal Height,  $H = 500.00$   
Internal Width,  $W = 200.00$   
Cover Thickness,  $c = 25.00$   
Mean Confinement Factor overall section = 1.00  
Element Length,  $L = 3000.00$   
Secondary Member  
Ribbed Bars  
Ductile Steel  
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)  
Longitudinal Bars With Ends Lapped Starting at the End Sections  
Adequate Lap Length ( $l_o/l_{ou,min} \geq 1$ )  
No FRP Wrapping

#### Stepwise Properties

At local axis: 2  
EDGE -A-  
Shear Force,  $V_a = 1.8202823E-014$   
EDGE -B-  
Shear Force,  $V_b = -1.8202823E-014$   
BOTH EDGES  
Axial Force,  $F = -2237.255$   
Longitudinal Reinforcement Area Distribution (in 2 divisions)  
-Tension:  $As_t = 709.9999$   
-Compression:  $As_c = 1668.186$   
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $As_{t,ten} = 911.0619$   
-Compression:  $As_{c,com} = 911.0619$   
-Middle:  $As_{mid} = 556.0619$

Calculation of Shear Capacity ratio,  $V_e/V_r = 0.53480887$   
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  
 $V_1 = 1.8202823E-014$ , is the shear force acting at edge 1 for the the static loading combination  
 $V_2 = -1.8202823E-014$ , is the shear force acting at edge 2 for the the static loading combination

## Calculation of Mu1+

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

$$\mu = 0.00010406$$

$$Mu = 3.0743E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear\_factor} * \text{Max}(\mu_c, \mu_o) = 0.00514506$$

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

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

$$\mu_o(5.4c) = 0.00169139$$

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

$$a_{se1} = 0.14776895$$

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

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

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

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

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

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

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

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

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

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

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

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

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

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  $fs_1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 694.45$   
 with  $Es_1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$   
 $y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$   
 $fy_2 = 694.45$   
 $su_2 = 0.032$   
 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.  
 $y_2, sh_2, ft_2, fy_2$ , are also multiplied by  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 694.45$   
 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  $Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$   
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.08015524$   
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.08015524$   
 $v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.04892233$   
 and confined core properties:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.09611636$   
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.09611636$   
 $v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.05866412$   
 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  $l_b/d$

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

Calculation of  $\mu_1$ -

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

$$\mu = 0.00010406$$

$$\mu = 3.0743E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

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

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

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

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

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

$$a_{se1} = 0.14776895$$

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

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

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

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

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

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

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

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

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

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

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

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

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

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

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

```

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) = 0.08015524
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) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
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
---->

```

$\mu_u(4.9) = 0.13857861$   
 $\mu_u = M_{Rc}(4.14) = 3.0743E+008$   
 $u = \mu_u(4.1) = 0.00010406$

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:

$u = 0.00010406$   
 $\mu_u = 3.0743E+008$

with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $\alpha(5A.5, TBDY) = 0.002$   
 Final value of  $\mu_u$ :  $\mu_u^* = \text{shear\_factor} * \text{Max}(\mu_u, \mu_c) = 0.00514506$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $\mu_u = 0.00514506$   
 $\mu_{ue}(5.4c) = 0.00169139$   
 $\alpha_{se}((5.4d), TBDY) = (\alpha_{se1} * A_{ext} + \alpha_{se2} * A_{int}) / A_{sec} = 0.14776895$   
 $\alpha_{se1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$

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

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

$\mu_{psh,x} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{psh2} * F_{ywe2} = 2.25223$   
 $\mu_{psh1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 No stirrups,  $n_{s\_1} = 2.00$   
 $h_1 = 670.00$   
 $\mu_{psh2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$   
 $A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$   
 No stirrups,  $n_{s\_2} = 2.00$   
 $h_2 = 500.00$

$\mu_{psh,y} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{psh2} * F_{ywe2} = 1.25908$   
 $\mu_{psh1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 No stirrups,  $n_{s\_1} = 2.00$   
 $h_1 = 400.00$   
 $\mu_{psh2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$   
 $A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$   
 No stirrups,  $n_{s\_2} = 2.00$   
 $h_2 = 200.00$

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

$fy_{we1} = 694.45$   
 $fy_{we2} = 694.45$   
 $f_{ce} = 33.00$   
 From ((5.A.5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $y_1 = 0.0025$   
 $sh_1 = 0.008$   
 $ft_1 = 833.34$   
 $fy_1 = 694.45$   
 $su_1 = 0.032$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $Shear\_factor = 1.00$   
 $lo/lou, min = lb/ld = 1.00$   
 $su_1 = 0.4 * esu_1\_nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esu_1\_nominal = 0.08$ ,  
 For calculation of  $esu_1\_nominal$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered  
 characteristic value  $fsy_1 = fs_1/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_1 = (fs_{jacket} * Asl_{ten, jacket} + fs_{core} * Asl_{ten, core}) / Asl_{ten} = 694.45$   
 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  
 $Shear\_factor = 1.00$   
 $lo/lou, min = lb/lb, min = 1.00$   
 $su_2 = 0.4 * esu_2\_nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esu_2\_nominal = 0.08$ ,  
 For calculation of  $esu_2\_nominal$  and  $y_2, sh_2, ft_2, fy_2$ , it is considered  
 characteristic value  $fsy_2 = fs_2/1.2$ , from table 5.1, TBDY.  
 $y_2, sh_2, ft_2, fy_2$ , are also multiplied by  $Min(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_2 = (fs_{jacket} * Asl_{com, jacket} + fs_{core} * Asl_{com, core}) / Asl_{com} = 694.45$   
 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  
 $Shear\_factor = 1.00$   
 $lo/lou, min = lb/ld = 1.00$   
 $suv = 0.4 * esuv\_nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv\_nominal = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv\_nominal$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y_v, sh_v, ft_v, fy_v$ , 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  $Es_v = (Es_{jacket} * Asl_{mid, jacket} + Es_{mid} * Asl_{mid, core}) / Asl_{mid} = 200000.00$   
 $1 = Asl_{ten} / (b * d) * (fs_1 / f_c) = 0.08015524$   
 $2 = Asl_{com} / (b * d) * (fs_2 / f_c) = 0.08015524$   
 $v = Asl_{mid} / (b * d) * (fsv / f_c) = 0.04892233$   
 and confined core properties:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl_{ten} / (b * d) * (fs_1 / f_c) = 0.09611636$   
 $2 = Asl_{com} / (b * d) * (fs_2 / f_c) = 0.09611636$   
 $v = Asl_{mid} / (b * d) * (fsv / f_c) = 0.05866412$

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

--->

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

--->

$\mu_u$  (4.9) = 0.13857861

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

$u = \mu_u$  (4.1) = 0.00010406

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:

$u = 0.00010406$

$M_u = 3.0743E+008$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$f_c = 33.00$

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

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

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

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

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

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

$\phi_{ase1} = 0.14776895$

$\phi_{bo\_1} = 340.00$

$\phi_{ho\_1} = 610.00$

$\phi_{bi2\_1} = 975400.00$

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

$\phi_{bo\_2} = 192.00$

$\phi_{ho\_2} = 492.00$

$\phi_{bi2\_2} = 557856.00$

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

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

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

$\phi_{ps1}$  (external) =  $(\phi_{Ash1} * h_1 / s_1) / A_{sec} = 0.00261799$

$\phi_{Ash1} = \phi_{Astir\_1} * n_{s\_1} = 157.0796$

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

$h_1 = 670.00$

$\phi_{ps2}$  (internal) =  $(\phi_{Ash2} * h_2 / s_2) / A_{sec} = 0.00062519$

$\phi_{Ash2} = \phi_{Astir\_2} * n_{s\_2} = 100.531$

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

$h_2 = 500.00$

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

$\phi_{ps1}$  (external) =  $(\phi_{Ash1} * h_1 / s_1) / A_{sec} = 0.00156298$

$\phi_{Ash1} = \phi_{Astir\_1} * n_{s\_1} = 157.0796$

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

$h_1 = 400.00$

$\phi_{ps2}$  (internal) =  $(\phi_{Ash2} * h_2 / s_2) / A_{sec} = 0.00025008$

$\phi_{Ash2} = \phi_{Astir\_2} * n_{s\_2} = 100.531$

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



$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From } ((5.5), \text{TB DY}), \text{TB DY: } c c = 0.002$$

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

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 833.34$$

$$fy1 = 694.45$$

$$su1 = 0.032$$

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

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

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

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

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

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

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

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

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 833.34$$

$$fy2 = 694.45$$

$$su2 = 0.032$$

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

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

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

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

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

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

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

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

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 833.34$$

$$fyv = 694.45$$

$$suv = 0.032$$

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

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

$$suv = 0.4 * esuv\_nominal ((5.5), \text{TB DY}) = 0.032$$

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

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

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

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

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

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

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

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

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc (5A.2, \text{TB DY}) = 33.00$$

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

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

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

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

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

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)

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

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

$$bw = 670.00$$

$$d = 320.00$$

$$Vu*d/Mu < 1 = 0.00$$

$$Mu = 4.0861879E-011$$

$$Vu = 1.8202823E-014$$

From (11.5.4.8), ACI 318-14:  $Vs1 + Vs2 = 186169.943$

$Vs1 = 186169.943$  is calculated for jacket, with:

$$d = 320.00$$

$$Av = 157079.633$$

$$fy = 555.56$$

$$s = 150.00$$

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

$Vs2 = 0.00$  is calculated for jacket, with:

$$d2 = 160.00$$

$$Av = 100530.965$$

$$fy = 555.56$$

$$s = 300.00$$

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

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

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

Calculation of Shear Strength at edge 2,  $Vr2 = 383231.42$

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

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

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

= 1 (normal-weight concrete)

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

pw =  $A_s/(b_w*d)$  = 0.00331157  
As (tension reinf.) = 709.9999  
bw = 670.00  
d = 320.00  
 $V_u*d/\mu_u < 1$  = 0.00  
 $\mu_u$  = 1.3749363E-011  
 $V_u$  = 1.8202823E-014

From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$

$V_{s1} = 186169.943$  is calculated for jacket, with:

d = 320.00  
 $A_v = 157079.633$   
 $f_y = 555.56$   
s = 150.00

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

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

d = 160.00  
 $A_v = 100530.965$   
 $f_y = 555.56$   
s = 300.00

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

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

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

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

-----  
Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1  
At local axis: 3  
Integration Section: (a)  
Section Type: rcjars

Constant Properties

-----  
Knowledge Factor,  $\gamma = 0.85$

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

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

Consequently:

Jacket

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

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

New material of Secondary 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,  $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping  
-----

Stepwise Properties  
-----

Bending Moment,  $M = -3.9023745E-011$   
 Shear Force,  $V2 = -2.4126677E-014$   
 Shear Force,  $V3 = 2658.348$   
 Axial Force,  $F = -3937.419$   
 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,  $DbL = 15.20$

New component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $\phi_R = 1.0^*$   $\phi = 0.00844124$   
 $\phi = \phi_y + \phi_p = 0.00844124$

- Calculation of  $\phi_y$  -

$\phi_y = (M_y * L_s / 3) / E_{eff} = 0.00344124$  ((4.29), Biskinis Phd))  
 $M_y = 1.9920E+008$   
 $L_s = M/V$  (with  $L_s > 0.1 * L$  and  $L_s < 2 * L$ ) = 1500.00  
 From table 10.5, ASCE 41\_17:  $E_{eff} = 0.3 * E_c * I_g = 2.8943E+013$

Calculation of Yielding Moment  $M_y$

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

$\phi_y = \text{Min}(\phi_{y,ten}, \phi_{y,com})$   
 $\phi_{y,ten} = 1.0020298E-005$   
 with  $f_y = 555.56$   
 $d = 357.00$   
 $\phi_y = 0.22348094$   
 $A = 0.00997229$   
 $B = 0.00559975$   
 with  $p_t = 0.00380895$   
 $p_c = 0.00380895$   
 $p_v = 0.00232477$   
 $N = 3937.419$   
 $b = 670.00$   
 $\phi = 0.12044818$   
 $\phi_{comp} = 2.7620672E-005$   
 with  $f_c = 33.00$   
 $E_c = 26999.444$   
 $\phi_y = 0.2231152$   
 $A = 0.00990525$   
 $B = 0.00557012$   
 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,  $\lambda / y < 2$  (table 10-6, ASCE 41-17)  
 $= -1.6654616E-022$

- Stirrup Spacing  $\leq d/2$

$d = d_{\text{external}} = 357.00$

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

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

$V_s = 215957.134$ , already given in calculation of shear control ratio

design Shear =  $2.4126677E-014$

-  $(\lambda - y) / \text{bal} = -0.23508921$

$= A_{st}/(b_w \cdot d) = 0.00296835$

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

$\lambda = A_{sc}/(b_w \cdot d) = 0.00697431$

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

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

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

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

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

From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + y) = 0.51922877$   
 $y = 0.0027778$

-  $V / (b_w \cdot d \cdot f_c^{0.5}) = 2.1145636E-019$ , NOTE: units in lb & in  
 $b_w = 670.00$

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

At local axis: 3

Integration Section: (a)

## Calculation No. 5

beam B1, Floor 1

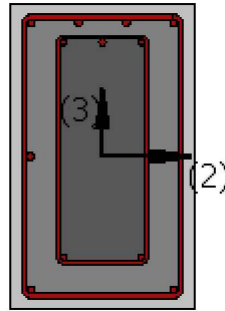
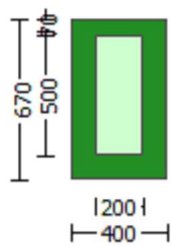
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity  $V_{Rd}$

Edge: End

Local Axis: (2)



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

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 0.85$

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

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment,  $M_a = -3.9023745E-011$

Shear Force,  $V_a = -2.4126677E-014$

EDGE -B-

Bending Moment,  $M_b = -3.3245903E-011$

Shear Force,  $V_b = 2.4126677E-014$

BOTH EDGES

Axial Force,  $F = -3937.419$

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:  $Asl_{mid} = 556.0619$

Mean Diameter of Tension Reinforcement,  $DbL_{ten} = 15.20$

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

NOTE: In expression (22.5.1.1) ' $V_w$ ' is replaced by ' $V_w + f'V_f$ '  
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:  $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 25.00$ , but  $fc'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

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

$As$  (tension reinf.) = 709.9999

$bw = 670.00$

$d = 320.00$

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

$Mu = 3.3245903E-011$

$V_u = 2.4126677E-014$

From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 167551.608$

$V_{s1} = 167551.608$  is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 500.00$

$s = 150.00$

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

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

$d = 160.00$

$A_v = 100530.965$

$f_y = 500.00$

$s = 300.00$

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

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

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

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

At local axis: 2

Integration Section: (b)

## Calculation No. 6

beam B1, Floor 1

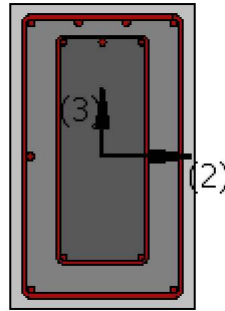
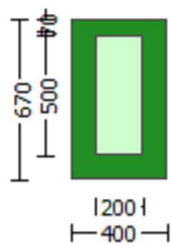
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity ( $\phi_r$ )

Edge: End

Local Axis: (2)



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

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 0.85$

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

Consequently:

Jacket

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

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

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

Jacket

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

Existing Column

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

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length,  $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force,  $V_a = 9840.632$

EDGE -B-

Shear Force,  $V_b = 9840.634$

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:  $As_{mid} = 402.1239$

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 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 static loading combination  
 and  
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$   
 with  
 $V_1 = 9840.632$ , is the shear force acting at edge 1 for the static loading combination  
 $V_2 = 9840.634$ , 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:  
 $\phi_u = 5.6088283E-005$   
 $M_u = 4.3734E+008$

with full section properties:

$b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $\phi_c \text{ (5A.5, TBDY)} = 0.002$   
 Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00514506$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $\phi_u = 0.00514506$   
 $w_e \text{ (5.4c)} = 0.00169139$   
 $\phi_{se} \text{ ((5.4d), TBDY)} = (\phi_{se1} \cdot A_{ext} + \phi_{se2} \cdot A_{int})/A_{sec} = 0.14776895$   
 $\phi_{se1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $\phi_{psh,min} \cdot F_{ywe} = \text{Min}(\phi_{psh,x} \cdot F_{ywe}, \phi_{psh,y} \cdot F_{ywe}) = 1.25908$   
 Expression ((5.4d), TBDY) for  $\phi_{psh,min} \cdot F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00261799$   
 $Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$   
 No stirups,  $ns\_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00062519$   
 $Ash2 = Astir\_2 \cdot ns\_2 = 100.531$   
 No stirups,  $ns\_2 = 2.00$   
 $h2 = 500.00$

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

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

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

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

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

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

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

with  $fs1 = (fs\_jacket \cdot Asl, ten, jacket + fs\_core \cdot Asl, ten, core) / Asl, ten = 694.45$

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  
 $Shear\_factor = 1.00$

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

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

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  $\text{Min}(1, 1.25 \cdot (lb/l_d)^{2/3})$ , 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  
 $Shear\_factor = 1.00$

$l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$   
 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  $fsv = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 694.45$   
 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:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl_{ten} / (b * d) * (fs1 / fc) = 0.0736092$   
 $2 = Asl_{com} / (b * d) * (fs2 / fc) = 0.13125889$   
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.04169017$   
 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  $l_b/l_d$

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

Calculation of  $Mu1$ -

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

$u = 5.9367084E-005$   
 $Mu = 7.4472E+008$

with full section properties:

$b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$   
 $fc = 33.00$   
 $co (5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00514506$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00514506$   
 $we (5.4c) = 0.00169139$   
 $ase ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo_1 = 340.00$   
 $ho_1 = 610.00$   
 $bi2_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo_2 = 192.00$   
 $ho_2 = 492.00$   
 $bi2_2 = 557856.00$

$psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.25908$   
 Expression ((5.4d), TBDY) for  $psh,min*Fywe$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

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

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

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

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

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) = 0.10623177
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) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
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
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00514506
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00514506
we (5.4c) = 0.00169139
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895

```

$bo\_1 = 340.00$   
 $ho\_1 = 610.00$   
 $bi2\_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$   
 $psh, min*Fywe = \text{Min}(psh, x*Fywe, psh, y*Fywe) = 1.25908$   
 Expression ((5.4d), TBDY) for  $psh, min*Fywe$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

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

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

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

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

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  $f_{sy2} = f_{s2}/1.2$ , 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  $f_{s2} = (f_{sjacket} \cdot A_{sl,mid,jacket} + f_{s,core} \cdot A_{sl,mid,core}) / A_{sl,com} = 694.45$   
 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  
 $l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $suv = 0.4 \cdot esuv\_nominal \text{ ((5.5), TBDY)} = 0.032$   
 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  $E_{sv} = (E_{sjacket} \cdot A_{sl,mid,jacket} + E_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 200000.00$   
 $1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.05957415$   
 $2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.10623177$   
 $v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.03374111$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} \text{ (5A.2, TBDY)} = 33.00$   
 $cc \text{ (5A.5, TBDY)} = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.0736092$   
 $2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.13125889$   
 $v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.04169017$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is satisfied  
 --->  
 $su \text{ (4.9)} = 0.09006517$   
 $Mu = MR_c \text{ (4.14)} = 4.3734E+008$   
 $u = su \text{ (4.1)} = 5.6088283E-005$

Calculation of ratio  $l_b/l_d$

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

Calculation of  $Mu_2$ -

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

$$u = 5.9367084E-005$$

$$Mu = 7.4472E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

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

The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $c_u = 0.00514506$   
 $w_e$  (5.4c) = 0.00169139  
 $a_{se}$  ((5.4d), TBDY) =  $(a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int}) / A_{sec} = 0.14776895$   
 $a_{se1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $p_{sh,min} \cdot F_{ywe} = \text{Min}(p_{sh,x} \cdot F_{ywe}, p_{sh,y} \cdot F_{ywe}) = 1.25908$   
 Expression ((5.4d), TBDY) for  $p_{sh,min} \cdot F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

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

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

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

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

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

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

$y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$   
 $fy_2 = 694.45$   
 $su_2 = 0.032$

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



Shear\_factor = 1.00  
 $l_o/l_{ou,min} = l_b/l_{b,min} = 1.00$   
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$   
 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  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , 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  $Es_2 = (Es_{jacket} \cdot Asl_{com,jacket} + Es_{core} \cdot Asl_{com,core}) / Asl_{com} = 200000.00$   
 $y_v = 0.0025$   
 $sh_v = 0.008$   
 $ft_v = 833.34$   
 $fy_v = 694.45$   
 $su_v = 0.032$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 694.45$   
 with  $Es_v = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$   
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.10623177$   
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.05957415$   
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.03374111$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.13125889$   
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.0736092$   
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.04169017$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < v_{s,y2}$  - 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  $l_b/l_d$

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

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

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

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

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

= 1 (normal-weight concrete)  
Mean concrete strength:  $fc' = (fc'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + fc'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 33.00$ , 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  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / \mu_u < 1 = 1.00$   
 $\mu_u = 1.0197 \times 10^6$   
 $V_u = 9840.632$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 349068.643$   
 $V_{s1} = 311834.654$  is calculated for jacket, with:  
 $d = 536.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17, 10.3.4)  
 $V_{s2} = 37233.989$  is calculated for jacket, with:  
 $d = 400.00$   
 $A_v = 100530.965$   
 $f_y = 555.56$   
 $s = 300.00$   
 $V_{s2}$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17, 10.3.4)  
 $2(1-s/d) = 0.50$   
 $V_f$  ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

-----  
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:  $fc' = (fc'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + fc'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 33.00$ , 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  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / \mu_u < 1 = 1.00$   
 $\mu_u = 1.0197 \times 10^6$   
 $V_u = 9840.634$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 349068.643$   
 $V_{s1} = 311834.654$  is calculated for jacket, with:  
 $d = 536.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17, 10.3.4)  
 $V_{s2} = 37233.989$  is calculated for jacket, with:  
 $d = 400.00$   
 $A_v = 100530.965$   
 $f_y = 555.56$   
 $s = 300.00$   
 $V_{s2}$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17, 10.3.4)  
 $2(1-s/d) = 0.50$   
 $V_f$  ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

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

```

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

Constant Properties
-----
Knowledge Factor,  $\phi = 0.85$ 
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$ 
New material of Secondary 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 Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$ 
New material of Secondary Member: Steel Strength,  $f_s = f_{sm} = 555.56$ 
Concrete Elasticity,  $E_c = 26999.444$ 
Steel Elasticity,  $E_s = 200000.00$ 
#####
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$ 
Existing Column
New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$ 
#####
External Height,  $H = 670.00$ 
External Width,  $W = 400.00$ 
Internal Height,  $H = 500.00$ 
Internal Width,  $W = 200.00$ 
Cover Thickness,  $c = 25.00$ 
Mean Confinement Factor overall section = 1.00
Element Length,  $L = 3000.00$ 
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ( $l_o/l_{ou,min} \geq 1$ )
No FRP Wrapping
-----

Stepwise Properties
-----
At local axis: 2
EDGE -A-
Shear Force,  $V_a = 1.8202823E-014$ 
EDGE -B-
Shear Force,  $V_b = -1.8202823E-014$ 
BOTH EDGES
Axial Force,  $F = -2237.255$ 
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension:  $A_{st} = 709.9999$ 
-Compression:  $A_{sc} = 1668.186$ 
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension:  $A_{st,ten} = 911.0619$ 
-Compression:  $A_{st,com} = 911.0619$ 
-Middle:  $A_{st,mid} = 556.0619$ 
-----
-----

Calculation of Shear Capacity ratio ,  $V_e/V_r = 0.53480887$ 
Member Controlled by Flexure ( $V_e/V_r < 1$ )
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 204955.561$ 

```

with  
 $M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 3.0743E+008$   
 $M_{u1+} = 3.0743E+008$ , is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination  
 $M_{u1-} = 3.0743E+008$ , is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination  
 $M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 3.0743E+008$   
 $M_{u2+} = 3.0743E+008$ , is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination  
 $M_{u2-} = 3.0743E+008$ , is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination  
and  
 $\pm v_w \cdot l_n = (|V1| + |V2|)/2$   
with  
 $V1 = 1.8202823E-014$ , is the shear force acting at edge 1 for the static loading combination  
 $V2 = -1.8202823E-014$ , is the shear force acting at edge 2 for the static loading combination

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

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

$u = 0.00010406$   
 $M_u = 3.0743E+008$   
-----

with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $\phi_0 (5A.5, \text{TBDY}) = 0.002$

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

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

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

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

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

$a_{se1} = 0.14776895$

$b_{o\_1} = 340.00$

$h_{o\_1} = 610.00$

$b_{i2\_1} = 975400.00$

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

$b_{o\_2} = 192.00$

$h_{o\_2} = 492.00$

$b_{i2\_2} = 557856.00$

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

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

-----  
 $\phi_{sh,x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{s2} * F_{ywe2} = 2.25223$   
 $\phi_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
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,  $n_{s\_2} = 2.00$   
 $h_2 = 500.00$   
-----

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

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

c = confinement factor = 1.00

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

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

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

y2 = 0.0025

sh2 = 0.008

ft2 = 833.34

fy2 = 694.45

su2 = 0.032

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

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

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

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

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

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

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

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

yv = 0.0025

shv = 0.008

ftv = 833.34

fyv = 694.45

suv = 0.032

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

lo/lou,min = lb/ld = 1.00

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

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

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

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

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

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

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

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

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) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
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) = 0.00514506
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00514506
we (5.4c) = 0.00169139
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.25908
Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

```

```

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25223
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 500.00

```

```

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

```

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

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

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

$$h1 = 400.00$$

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

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

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

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 694.45$$

$$fce = 33.00$$

$$\text{From } ((5A5), \text{TB DY}), \text{TB DY: } cc = 0.002$$

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

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 833.34$$

$$fy1 = 694.45$$

$$su1 = 0.032$$

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

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

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

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

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.

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

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

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

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 833.34$$

$$fy2 = 694.45$$

$$su2 = 0.032$$

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

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

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

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

For calculation of  $esu2_{\text{nominal}}$  and  $y2, sh2, ft2, fy2$ , it is considered  
characteristic value  $fsy2 = fs2/1.2$ , from table 5.1, TB DY.

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

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

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

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 833.34$$

$$fyv = 694.45$$

$$suv = 0.032$$

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

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

$$suv = 0.4 \cdot esuv_{\text{nominal}} ((5.5), \text{TB DY}) = 0.032$$

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

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

For calculation of  $esuv_{\text{nominal}}$  and  $yv, shv, ftv, fyv$ , it is considered  
characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TB DY.

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

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

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

$$1 = Asl, \text{ten} / (b \cdot d) \cdot (fs1 / fce) = 0.08015524$$

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

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

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

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

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

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

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

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

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

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

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

--->

$$s_u (4.9) = 0.13857861$$

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

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

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:

$$u = 0.00010406$$

$$\mu = 3.0743E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

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

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

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

$$\mu_e (5.4c) = 0.00169139$$

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

$$a_{se1} = 0.14776895$$

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

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

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

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

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

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

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

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

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

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

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

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

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

$$h_1 = 670.00$$

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



Ash2 = Astir\_2\*ns\_2 = 100.531  
 No stirups, ns\_2 = 2.00  
 h2 = 500.00

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

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

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

c = confinement factor = 1.00

y1 = 0.0025

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:

$b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $f_{cc} \text{ (5A.2, TBDY)} = 33.00$   
 $cc \text{ (5A.5, TBDY)} = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.09611636$   
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.09611636$   
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.05866412$

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  $Mu_2$ -

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

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

with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $cc \text{ (5A.5, TBDY)} = 0.002$   
 Final value of  $cu$ :  $cu^* = \text{shear\_factor} \cdot \text{Max}(cu, cc) = 0.00514506$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00514506$   
 $w_e \text{ (5.4c)} = 0.00169139$   
 $ase \text{ ((5.4d), TBDY)} = (ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo_1 = 340.00$   
 $ho_1 = 610.00$   
 $bi2_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo_2 = 192.00$   
 $ho_2 = 492.00$   
 $bi2_2 = 557856.00$

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

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

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

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

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

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

$$h1 = 670.00$$

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

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

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

$$h2 = 500.00$$

$$psh_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.25908$$

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

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

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

$$h1 = 400.00$$

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

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

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

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 694.45$$

$$fce = 33.00$$

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

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

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 833.34$$

$$fy1 = 694.45$$

$$su1 = 0.032$$

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

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

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

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

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

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

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

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

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 833.34$$

$$fy2 = 694.45$$

$$su2 = 0.032$$

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

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

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

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

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

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

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

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

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 833.34$$

$$fyv = 694.45$$

$$suv = 0.032$$

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

$l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $s_{uv} = 0.4 * e_{suv\_nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $e_{suv\_nominal} = 0.08$ ,  
 considering characteristic value  $f_{syv} = f_{sv}/1.2$ , from table 5.1, TBDY  
 For calculation of  $e_{suv\_nominal}$  and  $y_v$ ,  $sh_v, ft_v, f_{yv}$ , it is considered  
 characteristic value  $f_{syv} = f_{sv}/1.2$ , from table 5.1, TBDY.  
 $y_1$ ,  $sh_1, ft_1, f_{y1}$ , are also multiplied by  $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $f_{sv} = (f_{sj\_jacket} * A_{sl,mid,jacket} + f_{sj,mid} * A_{sl,mid,core}) / A_{sl,mid} = 694.45$   
 with  $E_{sv} = (E_{sj\_jacket} * A_{sl,mid,jacket} + E_{sj,mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$   
 $1 = A_{sl,ten} / (b * d) * (f_{s1}/f_c) = 0.08015524$   
 $2 = A_{sl,com} / (b * d) * (f_{s2}/f_c) = 0.08015524$   
 $v = A_{sl,mid} / (b * d) * (f_{sv}/f_c) = 0.04892233$

and confined core properties:

$b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten} / (b * d) * (f_{s1}/f_c) = 0.09611636$   
 $2 = A_{sl,com} / (b * d) * (f_{s2}/f_c) = 0.09611636$   
 $v = A_{sl,mid} / (b * d) * (f_{sv}/f_c) = 0.05866412$

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

--->

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

--->

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

Calculation of ratio  $l_b/l_d$

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

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

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

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:  $V_c = 197061.477$   
 $= 1$  (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)  
 $p_w = A_s / (b_w * d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u * d / Mu < 1 = 0.00$   
 $Mu = 4.0861879E-011$   
 $V_u = 1.8202823E-014$   
 From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$   
 $V_{s1} = 186169.943$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17, 10.3.4)  
 $V_{s2} = 0.00$  is calculated for jacket, with:  
 $d_2 = 160.00$

$$A_v = 100530.965$$

$$f_y = 555.56$$

$$s = 300.00$$

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

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

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

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 (normal-weight concrete)

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

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

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

$$b_w = 670.00$$

$$d = 320.00$$

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

$$M_u = 1.3749363E-011$$

$$V_u = 1.8202823E-014$$

$$\text{From (11.5.4.8), ACI 318-14: } V_{s1} + V_{s2} = 186169.943$$

$V_{s1} = 186169.943$  is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

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)

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

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

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

$$\text{Knowledge Factor, } \phi = 0.85$$

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

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

Consequently:

Jacket

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

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

$$\text{Concrete Elasticity, } E_c = 26999.444$$

$$\text{Steel Elasticity, } E_s = 200000.00$$

Existing Column

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

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

$$\text{Concrete Elasticity, } E_c = 26999.444$$

$$\text{Steel Elasticity, } E_s = 200000.00$$

External Height, H = 670.00  
 External Width, W = 400.00  
 Internal Height, H = 500.00  
 Internal Width, W = 200.00  
 Cover Thickness, c = 25.00  
 Element Length, L = 3000.00  
 Secondary Member  
 Ribbed Bars  
 Ductile Steel  
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)  
 Longitudinal Bars With Ends Lapped Starting at the End Sections  
 Adequate Lap Length ( $l_b/d \geq 1$ )  
 No FRP Wrapping

#### Stepwise Properties

Bending Moment, M = 1.2916E+007  
 Shear Force, V2 = 2.4126677E-014  
 Shear Force, V3 = 17022.918  
 Axial Force, F = -3937.419  
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
   -Tension: Asl,t = 709.9999  
   -Compression: Asl,c = 1668.186  
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
   -Tension: Asl,ten = 709.9999  
   -Compression: Asl,com = 1266.062  
   -Middle: Asl,mid = 402.1239  
 Longitudinal External Reinforcement Area Distribution (in 3 divisions)  
   -Tension: Asl,ten,jacket = 402.1239  
   -Compression: Asl,com,jacket = 804.2477  
   -Middle: Asl,mid,jacket = 402.1239  
 Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)  
   -Tension: Asl,ten,core = 307.8761  
   -Compression: Asl,com,core = 461.8141  
   -Middle: Asl,mid,core = 0.00  
 Mean Diameter of Tension Reinforcement, DbL = 15.00

New component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u_R = 1.0^*$   $u = 0.01085223$   
 $u = y + p = 0.01085223$

- Calculation of  $y$  -

$y = (M_y * L_s / 3) / E_{eff} = 0.00085223$  ((4.29), Biskinis Phd))  
 $M_y = 2.7362E+008$   
 $L_s = M/V$  (with  $L_s > 0.1 * L$  and  $L_s < 2 * L$ ) = 758.7609  
 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 -

$y = \text{Min}(y_{ten}, y_{com})$   
 $y_{ten} = 5.4344943E-006$   
 with  $f_y = 555.56$   
 $d = 627.00$   
 $y = 0.184781$   
 $A = 0.00951066$   
 $B = 0.00406206$   
 with  $p_t = 0.00283094$   
 $p_c = 0.00504809$

$p_v = 0.00160336$   
 $N = 3937.419$   
 $b = 400.00$   
 $" = 0.06858054$   
 $y_{comp} = 1.9038515E-005$   
 with  $f_c = 33.00$   
 $E_c = 26999.444$   
 $y = 0.18430241$   
 $A = 0.00944672$   
 $B = 0.0040338$   
 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,  $\gamma < 2$  (table 10-6, ASCE 41-17)  
 $= 3.4531051E-006$
- 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 = 17022.918
- $(\rho_t - \rho_c)/\rho_{bal} = -0.22420649$   
 $= A_{st}/(b_w \times d) = 0.00283094$   
 Tension Reinf Area:  $A_{st} = 709.9999$   
 $\rho_c = A_{sc}/(b_w \times d) = 0.00665146$   
 Compression Reinf Area:  $A_{sc} = 1668.186$
- From (B-1), ACI 318-11:  $\rho_{bal} = 0.01704017$   
 $f_c = (f_{c\_jacket} \times \text{Area}_{jacket} + f_{c\_core} \times \text{Area}_{core}) / \text{section\_area} = 33.00$   
 $f_y = f_{y\_jacket\_bars} = 555.56$   
 From 10.2.7.3, ACI 318-11:  $\beta_1 = 0.65$   
 From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + \gamma) = 0.51922877$   
 $\gamma = 0.0027778$
- $V / (b_w \times d \times f_c^{0.5}) = 0.14228946$ , NOTE: units in  $I_b$  & 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

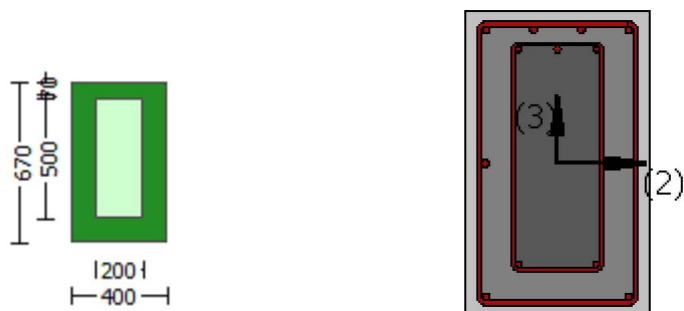
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity  $VR_d$

Edge: End

Local Axis: (3)



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

At local axis: 3

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 0.85$

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

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ( $l_o/l_{ou,min} = l_b/l_d \geq 1$ )

No FRP Wrapping

Stepwise Properties

EDGE -A-



Bending Moment,  $M_a = 8.6307E+006$

Shear Force,  $V_a = 2658.348$

EDGE -B-

Bending Moment,  $M_b = 1.2916E+007$

Shear Force,  $V_b = 17022.918$

BOTH EDGES

Axial Force,  $F = -3937.419$

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  $VR = 1.0 \cdot V_n = 494205.693$

$V_n$  ((22.5.1.1), ACI 318-14) = 494205.693

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:  $V_c = 180046.428$

= 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

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / M_u < 1 = 0.70641493$

$M_u = 1.2916E+007$

$V_u = 17022.918$

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

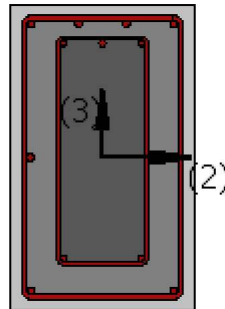
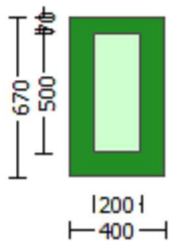
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

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,  $\phi = 0.85$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$

Existing Column

New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$   
 Mean Confinement Factor overall section = 1.00  
 Element Length,  $L = 3000.00$   
 Secondary Member  
 Ribbed Bars  
 Ductile Steel  
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)  
 Longitudinal Bars With Ends Lapped Starting at the End Sections  
 Adequate Lap Length ( $l_o/l_{ou}, \min \geq 1$ )  
 No FRP Wrapping

#### Stepwise Properties

At local axis: 3  
 EDGE -A-  
 Shear Force,  $V_a = 9840.632$   
 EDGE -B-  
 Shear Force,  $V_b = 9840.634$   
 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:  $As_{mid} = 402.1239$

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  
 $V_1 = 9840.632$ , is the shear force acting at edge 1 for the static loading combination  
 $V_2 = 9840.634$ , 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:  
 $\phi_u = 5.6088283E-005$   
 $M_u = 4.3734E+008$

with full section properties:

$b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$

$f_c = 33.00$   
 $c_o (5A.5, TBDY) = 0.002$   
 Final value of  $c_u$ :  $c_u^* = \text{shear\_factor} * \text{Max}(c_u, c_o) = 0.00514506$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $c_u = 0.00514506$   
 $w_e (5.4c) = 0.00169139$   
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$   
 $a_{se1} = 0.14776895$   
 $b_o_1 = 340.00$   
 $h_o_1 = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$   
 $b_o_2 = 192.00$   
 $h_o_2 = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$   
 Expression ((5.4d), TBDY) for  $p_{sh, \min} * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.25223$   
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 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.A5), TBDY), TBDY:  $c_c = 0.002$   
 $c = \text{confinement factor} = 1.00$

$y_1 = 0.0025$   
 $sh_1 = 0.008$   
 $ft_1 = 833.34$   
 $fy_1 = 694.45$   
 $su_1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$

$l_o / l_{ou, \min} = l_b / l_d = 1.00$

$su_1 = 0.4 * esu_{1\_nominal} ((5.5), TBDY) = 0.032$

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  $fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 694.45$

with  $Es_1 = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$

$y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$   
 $fy_2 = 694.45$

```

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) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
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:

$b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $\phi (5A.5, \text{TB DY}) = 0.002$   
 Final value of  $\phi$ :  $\phi^* = \text{shear\_factor} * \text{Max}(\phi, \phi_c) = 0.00514506$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TB DY:  $\phi = 0.00514506$   
 $\phi (5.4c) = 0.00169139$   
 $\phi (5.4d), \text{TB DY} = (\phi_1 * A_{ext} + \phi_2 * A_{int}) / A_{sec} = 0.14776895$   
 $\phi_1 = 0.14776895$   
 $\phi_{o1} = 340.00$   
 $\phi_{h1} = 610.00$   
 $\phi_{i21} = 975400.00$   
 $\phi_2 = \text{Max}(\phi_1, \phi_2) = 0.14776895$   
 $\phi_{o2} = 192.00$   
 $\phi_{h2} = 492.00$   
 $\phi_{i22} = 557856.00$   
 $\phi_{min} * F_{ywe} = \text{Min}(\phi_{sh,x} * F_{ywe}, \phi_{sh,y} * F_{ywe}) = 1.25908$   
 Expression ((5.4d), TB DY) for  $\phi_{min} * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

---

$\phi_{sh,x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.25223$   
 $\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 No stirrups,  $n_{s\_1} = 2.00$   
 $h_1 = 670.00$   
 $\phi_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$   
 $A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$   
 No stirrups,  $n_{s\_2} = 2.00$   
 $h_2 = 500.00$

---

$\phi_{sh,y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.25908$   
 $\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 No stirrups,  $n_{s\_1} = 2.00$   
 $h_1 = 400.00$   
 $\phi_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$   
 $A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$   
 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), TB DY), TB DY:  $\phi_c = 0.002$   
 $\phi_c = \text{confinement factor} = 1.00$   
 $y_1 = 0.0025$   
 $sh_1 = 0.008$   
 $ft_1 = 833.34$   
 $fy_1 = 694.45$   
 $su_1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $\phi_o / \phi_{ou,min} = \phi_o / \phi_d = 1.00$   
 $\phi_{su1} = 0.4 * \phi_{su1\_nominal} ((5.5), \text{TB DY}) = 0.032$   
 From table 5A.1, TB DY:  $\phi_{su1\_nominal} = 0.08$ ,  
 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, TB DY.  
 $y_1$ ,  $sh_1$ ,  $ft_1$ ,  $fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 * (\phi_o / \phi_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $f_{s1} = (f_{s,jacket} * A_{sl,ten,jacket} + f_{s,core} * A_{sl,ten,core}) / A_{sl,ten} = 694.45$

```

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) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
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:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$\alpha (5A.5, TBDY) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.00514506$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.00514506$$

$$\phi_{ue} \text{ (5.4c)} = 0.00169139$$

$$\alpha_{se} \text{ ((5.4d), TBDY)} = (\alpha_{se1} * A_{ext} + \alpha_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$\alpha_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

$$\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.14776895$$

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

$$\phi_{sh,min} * F_{ywe} = \text{Min}(\phi_{sh,x} * F_{ywe}, \phi_{sh,y} * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for  $\phi_{sh,min} * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{sh,x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.25223$$

$$\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{sh,y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.25908$$

$$\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$f_{t1} = 833.34$$

$$f_{y1} = 694.45$$

$$s_{u1} = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00



$l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $su_1 = 0.4 \cdot esu_{1,nominal} ((5.5), TBDY) = 0.032$   
 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  $fs_1 = (fs_{jacket} \cdot Asl_{ten,jacket} + fs_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 694.45$   
 with  $Es_1 = (Es_{jacket} \cdot Asl_{ten,jacket} + Es_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 200000.00$   
 $y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$   
 $fy_2 = 694.45$   
 $su_2 = 0.032$   
 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  
 $l_o/l_{ou,min} = l_b/l_{b,min} = 1.00$   
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$   
 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  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , 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  
 $l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 694.45$   
 with  $Esv = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$   
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.05957415$   
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.10623177$   
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.03374111$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.0736092$   
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.13125889$   
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.04169017$   
 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  $l_b/l_d$

Adequate Lap Length:  $l_b/l_d \geq 1$

## 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:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$cc \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear\_factor} * \text{Max}(\mu, cc) = 0.00514506$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu = 0.00514506$$

$$\mu_e \text{ (5.4c)} = 0.00169139$$

$$\mu_{se} \text{ ((5.4d), TBDY)} = (\mu_{se1} * A_{ext} + \mu_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$\mu_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

$$\mu_{se2} = \text{Max}(\mu_{se1}, \mu_{se2}) = 0.14776895$$

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

$$\mu_{psh, \min} * F_{ywe} = \text{Min}(\mu_{psh, x} * F_{ywe}, \mu_{psh, y} * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for  $\mu_{psh, \min} * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\mu_{psh, x} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{psh2} * F_{ywe2} = 2.25223$$

$$\mu_{psh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

$$\mu_{psh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

$$\mu_{psh, y} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{psh2} * F_{ywe2} = 1.25908$$

$$\mu_{psh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

$$\mu_{psh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

```

fy1 = 694.45
su1 = 0.032
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/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) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    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 ' $V_w + f_v V_f$ ' 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  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / \mu < 1 = 1.00$   
 $\mu = 1.0197E+006$   
 $V_u = 9840.632$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 349068.643$   
 $V_{s1} = 311834.654$  is calculated for jacket, with:  
 $d = 536.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17, 10.3.4)  
 $V_{s2} = 37233.989$  is calculated for jacket, with:  
 $d_2 = 400.00$   
 $A_v = 100530.965$   
 $f_y = 555.56$   
 $s = 300.00$   
 $V_{s2}$  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 ' $V_w + f_v V_f$ ' 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  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / \mu < 1 = 1.00$   
 $\mu = 1.0197E+006$   
 $V_u = 9840.634$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 349068.643$   
 $V_{s1} = 311834.654$  is calculated for jacket, with:  
 $d = 536.00$

Av = 157079.633

fy = 555.56

s = 150.00

Vs1 has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

Vs2 = 37233.989 is calculated for jacket, with:

d = 400.00

Av = 100530.965

fy = 555.56

s = 300.00

Vs2 has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440:  $Vs + Vf \leq 818179.336$

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, = 0.85

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$

Existing Column

New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length,  $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ( $l_o/l_{ou}, \min > 1$ )

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-  
 Shear Force,  $V_a = 1.8202823E-014$   
 EDGE -B-  
 Shear Force,  $V_b = -1.8202823E-014$   
 BOTH EDGES  
 Axial Force,  $F = -2237.255$   
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
   -Tension:  $As_t = 709.9999$   
   -Compression:  $As_c = 1668.186$   
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $As_{t,ten} = 911.0619$   
   -Compression:  $As_{c,com} = 911.0619$   
   -Middle:  $As_{mid} = 556.0619$

-----  
 -----  
  
 Calculation of Shear Capacity ratio ,  $V_e/V_r = 0.53480887$   
 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  
 $V_1 = 1.8202823E-014$ , is the shear force acting at edge 1 for the the static loading combination  
 $V_2 = -1.8202823E-014$ , 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:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $\phi_{co} \text{ (5A.5, TBDY)} = 0.002$   
 Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00514506$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $\phi_u = 0.00514506$   
 $w_e \text{ (5.4c)} = 0.00169139$   
 $ase \text{ ((5.4d), TBDY)} = (ase1 \cdot A_{ext} + ase2 \cdot A_{int})/A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo\_1 = 340.00$   
 $ho\_1 = 610.00$   
 $bi2\_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$

$psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.25908$   
 Expression ((5.4d), TBDY) for  $psh,min*Fywe$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.25223$   
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00261799$   
 $Ash1 = Astir\_1*ns\_1 = 157.0796$   
 No stirrups,  $ns\_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00062519$   
 $Ash2 = Astir\_2*ns\_2 = 100.531$   
 No stirrups,  $ns\_2 = 2.00$   
 $h2 = 500.00$

$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.25908$   
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00156298$   
 $Ash1 = Astir\_1*ns\_1 = 157.0796$   
 No stirrups,  $ns\_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00025008$   
 $Ash2 = Astir\_2*ns\_2 = 100.531$   
 No stirrups,  $ns\_2 = 2.00$   
 $h2 = 200.00$

$Asec = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fywe1 = 694.45$   
 $fywe2 = 694.45$   
 $fce = 33.00$

From ((5.A5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$

$y1 = 0.0025$   
 $sh1 = 0.008$   
 $ft1 = 833.34$   
 $fy1 = 694.45$   
 $su1 = 0.032$

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) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    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) = 0.00514506
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00514506
we (5.4c) = 0.00169139
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00

```



$bi2\_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$   
 $psh, \min * Fywe = \text{Min}(psh, x * Fywe, psh, y * Fywe) = 1.25908$   
 Expression ((5.4d), TBDY) for  $psh, \min * Fywe$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh\_x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 2.25223$   
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00261799$   
 $Ash1 = Astir\_1 * ns\_1 = 157.0796$   
 No stirrups,  $ns\_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00062519$   
 $Ash2 = Astir\_2 * ns\_2 = 100.531$   
 No stirrups,  $ns\_2 = 2.00$   
 $h2 = 500.00$

$psh\_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.25908$   
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00156298$   
 $Ash1 = Astir\_1 * ns\_1 = 157.0796$   
 No stirrups,  $ns\_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00025008$   
 $Ash2 = Astir\_2 * ns\_2 = 100.531$   
 No stirrups,  $ns\_2 = 2.00$   
 $h2 = 200.00$

$Asec = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fywe1 = 694.45$   
 $fywe2 = 694.45$   
 $fce = 33.00$

From ((5.A5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$

$y1 = 0.0025$   
 $sh1 = 0.008$   
 $ft1 = 833.34$   
 $fy1 = 694.45$   
 $su1 = 0.032$

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,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) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09611636
2 = Asl,com/(b*d)*(fs2/fc) = 0.09611636
v = Asl,mid/(b*d)*(fsv/fc) = 0.05866412
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.13857861
Mu = MRc (4.14) = 3.0743E+008
u = su (4.1) = 0.00010406

```

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

```

u = 0.00010406
Mu = 3.0743E+008

```

with full section properties:

```

b = 670.00
d = 357.00
d' = 43.00
v = 0.00028344
N = 2237.255
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00514506
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00514506

```

$w_e (5.4c) = 0.00169139$   
 $ase ((5.4d), TBDY) = (ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo\_1 = 340.00$   
 $ho\_1 = 610.00$   
 $bi2\_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$

$psh, min \cdot F_{ywe} = \text{Min}(psh, x \cdot F_{ywe}, psh, y \cdot F_{ywe}) = 1.25908$   
 Expression ((5.4d), TBDY) for  $psh, min \cdot F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh, x \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 2.25223$   
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.00261799$   
 $Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$   
 No stirrups,  $ns\_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00062519$   
 $Ash2 = Astir\_2 \cdot ns\_2 = 100.531$   
 No stirrups,  $ns\_2 = 2.00$   
 $h2 = 500.00$

$psh, y \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 1.25908$   
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.00156298$   
 $Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$   
 No stirrups,  $ns\_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00025008$   
 $Ash2 = Astir\_2 \cdot ns\_2 = 100.531$   
 No stirrups,  $ns\_2 = 2.00$   
 $h2 = 200.00$

$A_{sec} = 268000.00$

$s1 = 150.00$

$s2 = 300.00$

$fywe1 = 694.45$

$fywe2 = 694.45$

$f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY:  $cc = 0.002$

$c = \text{confinement factor} = 1.00$

$y1 = 0.0025$

$sh1 = 0.008$

$ft1 = 833.34$

$fy1 = 694.45$

$su1 = 0.032$

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

$lo/lo, min = lb/ld = 1.00$

$su1 = 0.4 \cdot esu1\_nominal ((5.5), TBDY) = 0.032$

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 Shear\_factor = 1.00

$lo/lo, min = lb/lb, min = 1.00$

$su_2 = 0.4 * esu_{2\_nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esu_{2\_nominal} = 0.08$ ,  
 For calculation of  $esu_{2\_nominal}$  and  $y_2, sh_2, ft_2, fy_2$ , it is considered  
 characteristic value  $fsy_2 = fs_2/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_2 = (fs_{jacket} * Asl_{com,jacket} + fs_{core} * Asl_{com,core}) / Asl_{com} = 694.45$   
 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  
 $lo/lo_{u,min} = lb/ld = 1.00$   
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fsyv = fs_v/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fsyv = fs_v/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_v = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 694.45$   
 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:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.09611636$   
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.09611636$   
 $v = Asl_{mid} / (b * d) * (fs_v / fc) = 0.05866412$   
 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  $lb/ld$

-----

Adequate Lap Length:  $lb/ld \geq 1$

-----

-----

Calculation of  $Mu_2$ -

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-----

Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:

$u = 0.00010406$   
 $Mu = 3.0743E+008$

-----

with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$

$f_c = 33.00$   
 $c_o (5A.5, TBDY) = 0.002$   
 Final value of  $c_u$ :  $c_u^* = \text{shear\_factor} * \text{Max}(c_u, c_o) = 0.00514506$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $c_u = 0.00514506$   
 $w_e (5.4c) = 0.00169139$   
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$   
 $a_{se1} = 0.14776895$   
 $b_o_1 = 340.00$   
 $h_o_1 = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$   
 $b_o_2 = 192.00$   
 $h_o_2 = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$   
 Expression ((5.4d), TBDY) for  $p_{sh, \min} * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.25223$   
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 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.A5), TBDY), TBDY:  $c_c = 0.002$   
 $c = \text{confinement factor} = 1.00$

$y_1 = 0.0025$   
 $sh_1 = 0.008$   
 $ft_1 = 833.34$   
 $fy_1 = 694.45$   
 $su_1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$

$l_o / l_{ou, \min} = l_b / l_d = 1.00$

$su_1 = 0.4 * esu_{1\_nominal} ((5.5), TBDY) = 0.032$

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  $fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 694.45$

with  $Es_1 = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$

$y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$   
 $fy_2 = 694.45$

```

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) = 0.08015524
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) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
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/lb

Adequate Lap Length: lb/lb >= 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:  $V_c = 197061.477$   
 $= 1$  (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot Area\_jacket + f'_{c\_core} \cdot Area\_core) / Area\_section = 33.00$ , but  $f_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $p_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 4.0861879E-011$   
 $V_u = 1.8202823E-014$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$   
 $V_{s1} = 186169.943$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 0.00$  is calculated for jacket, with:  
 $d = 160.00$   
 $A_v = 100530.965$   
 $f_y = 555.56$   
 $s = 300.00$   
 $V_{s2}$  is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)  
 $V_f$  ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

-----  
Calculation of Shear Strength at edge 2,  $V_{r2} = 383231.42$   
 $V_{r2} = V_n$  ((22.5.1.1), ACI 318-14)

-----  
NOTE: In expression (22.5.1.1) ' $V_w$ ' is replaced by ' $V_w + f \cdot V_f$ '  
where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

-----  
From Table (22.5.5.1), ACI 318-14:  $V_c = 197061.477$   
 $= 1$  (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot Area\_jacket + f'_{c\_core} \cdot Area\_core) / Area\_section = 33.00$ , but  $f_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $p_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 1.3749363E-011$   
 $V_u = 1.8202823E-014$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$   
 $V_{s1} = 186169.943$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 0.00$  is calculated for jacket, with:  
 $d = 160.00$   
 $A_v = 100530.965$   
 $f_y = 555.56$   
 $s = 300.00$   
 $V_{s2}$  is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)  
 $V_f$  ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

-----  
End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1  
At local axis: 2

-----  
Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3  
Integration Section: (b)  
Section Type: rcjars

#### Constant Properties

Knowledge Factor,  $\gamma = 0.85$   
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.  
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17  
Consequently:  
Jacket  
New material of Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$   
New material of Secondary 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 Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$   
New material of Secondary 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,  $L = 3000.00$   
Secondary Member  
Ribbed Bars  
Ductile Steel  
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)  
Longitudinal Bars With Ends Lapped Starting at the End Sections  
Adequate Lap Length ( $l_b/d \geq 1$ )  
No FRP Wrapping

#### Stepwise Properties

Bending Moment,  $M = -3.3245903E-011$   
Shear Force,  $V_2 = 2.4126677E-014$   
Shear Force,  $V_3 = 17022.918$   
Axial Force,  $F = -3937.419$   
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  $u_R = 1.0^*$   $u = 0.00844124$   
 $u = \gamma + p = 0.00844124$

- Calculation of  $\gamma$  -



$y = (M_y * L_s / 3) / E_{eff} = 0.00344124 \text{ ((4.29), Biskinis Phd)}$   
 $M_y = 1.9920E+008$   
 $L_s = M/V \text{ (with } L_s > 0.1 * L \text{ and } L_s < 2 * L) = 1500.00$   
 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 -

$y = \text{Min}(y_{ten}, y_{com})$   
 $y_{ten} = 1.0020298E-005$   
 with  $f_y = 555.56$   
 $d = 357.00$   
 $y = 0.22348094$   
 $A = 0.00997229$   
 $B = 0.00559975$   
 with  $p_t = 0.00380895$   
 $p_c = 0.00380895$   
 $p_v = 0.00232477$   
 $N = 3937.419$   
 $b = 670.00$   
 $" = 0.12044818$   
 $y_{comp} = 2.7620672E-005$   
 with  $f_c = 33.00$   
 $E_c = 26999.444$   
 $y = 0.2231152$   
 $A = 0.00990525$   
 $B = 0.00557012$   
 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,  $\phi / y < 2$  (table 10-6, ASCE 41-17)  
 $= 3.7381506E-022$
- Stirrup Spacing  $\leq d/2$   
 $d = d_{external} = 357.00$   
 $s = s_{external} = 150.00$
- Strength provided by hoops  $V_s < 3/4 * \text{design Shear}$   
 $V_s = 215957.134$ , already given in calculation of shear control ratio  
 design Shear =  $2.4126677E-014$
- $(\phi - \phi') / \phi_{bal} = -0.23508921$   
 $= A_{st} / (b_w * d) = 0.00296835$   
 Tension Reinf Area:  $A_{st} = 709.9999$   
 $\phi' = A_{sc} / (b_w * d) = 0.00697431$   
 Compression Reinf Area:  $A_{sc} = 1668.186$
- From (B-1), ACI 318-11:  $\phi_{bal} = 0.01704017$   
 $f_c = (f_{c\_jacket} * \text{Area}_{jacket} + f_{c\_core} * \text{Area}_{core}) / \text{section\_area} = 33.00$   
 $f_y = f_{y\_jacket\_bars} = 555.56$   
 From 10.2.7.3, ACI 318-11:  $\phi = 0.65$   
 From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000 / (87000 + f_y) = c_b/dt = 0.003 / (0.003 + y) = 0.51922877$   
 $y = 0.0027778$
- $V / (b_w * d * f_c^{0.5}) = 2.1145636E-019$ , NOTE: units in lb & in

bw = 670.00

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)

## Calculation No. 9

beam B1, Floor 1

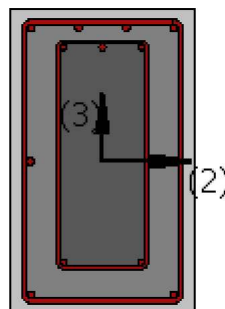
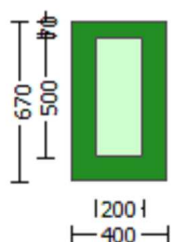
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 0.85$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Secondary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Secondary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Secondary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Secondary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$   
 External Height,  $H = 670.00$   
 External Width,  $W = 400.00$   
 Internal Height,  $H = 500.00$   
 Internal Width,  $W = 200.00$   
 Cover Thickness,  $c = 25.00$   
 Element Length,  $L = 3000.00$   
 Secondary Member  
 Ribbed Bars  
 Ductile Steel  
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)  
 Longitudinal Bars With Ends Lapped Starting at the End Sections  
 Adequate Lap Length ( $l_o/l_{ou,min} = l_b/l_d \geq 1$ )  
 No FRP Wrapping

#### Stepwise Properties

EDGE -A-  
 Bending Moment,  $M_a = -2.3875458E-011$   
 Shear Force,  $V_a = -1.6099959E-014$   
 EDGE -B-  
 Bending Moment,  $M_b = -2.4334440E-011$   
 Shear Force,  $V_b = 1.6099959E-014$   
 BOTH EDGES  
 Axial Force,  $F = -3615.026$   
 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)  
 $p_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 2.3875458E-011$   
 $V_u = 1.6099959E-014$   
 From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 167551.608$   
 $V_{s1} = 167551.608$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 500.00$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17, 10.3.4)  
 $V_{s2} = 0.00$  is calculated for core, with:  
 $d = 160.00$   
 $A_v = 100530.965$   
 $f_y = 500.00$   
 $s = 300.00$

Vs2 is considered 0 ( $s > d$ , according to ASCE 41-17, 10.3.4)

$V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$

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: 2

Integration Section: (a)

## Calculation No. 10

beam B1, Floor 1

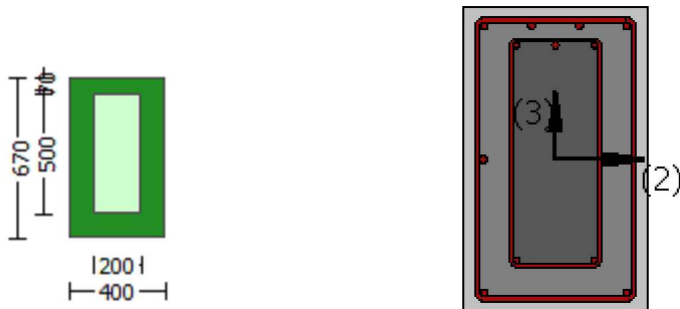
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

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,  $\phi = 0.85$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,  
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$

Existing Column

New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length,  $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ( $l_o/l_{ou,min} \geq 1$ )

No FRP Wrapping

-----  
Stepwise Properties

-----  
At local axis: 3

EDGE -A-

Shear Force,  $V_a = 9840.632$

EDGE -B-

Shear Force,  $V_b = 9840.634$

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

$M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 7.4472E+008$

$Mu_{1+} = 4.3734E+008$ , 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

$V_1 = 9840.632$ , is the shear force acting at edge 1 for the the static loading combination

$V_2 = 9840.634$ , 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:

$$u = 5.6088283E-005$$

$$Mu = 4.3734E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$\alpha (5A.5, TBDY) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.00514506$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.00514506$$

$$\phi_{ue} \text{ (5.4c)} = 0.00169139$$

$$\alpha_{se} \text{ ((5.4d), TBDY)} = (\alpha_{se1} * A_{ext} + \alpha_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$\alpha_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

$$\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.14776895$$

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

$$\phi_{sh,min} * F_{ywe} = \text{Min}(\phi_{sh,x} * F_{ywe}, \phi_{sh,y} * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for  $\phi_{sh,min} * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{sh,x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.25223$$

$$\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{sh,y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.25908$$

$$\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$f_{t1} = 833.34$$

$$f_{y1} = 694.45$$

$$s_{u1} = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor

and also multiplied by the shear\_factor according to 15.7.1.4, with

$$\text{Shear\_factor} = 1.00$$

$l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $su_1 = 0.4 \cdot esu_{1,nominal} ((5.5), TBDY) = 0.032$   
 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  $fs_1 = (fs_{jacket} \cdot Asl_{ten,jacket} + fs_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 694.45$   
 with  $Es_1 = (Es_{jacket} \cdot Asl_{ten,jacket} + Es_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 200000.00$   
 $y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$   
 $fy_2 = 694.45$   
 $su_2 = 0.032$   
 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  
 $l_o/l_{ou,min} = l_b/l_{b,min} = 1.00$   
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$   
 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  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , 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  
 $l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 694.45$   
 with  $Esv = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$   
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.05957415$   
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.10623177$   
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.03374111$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.0736092$   
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.13125889$   
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.04169017$   
 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  $l_b/l_d$

Adequate Lap Length:  $l_b/l_d \geq 1$

## Calculation of Mu1-

Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:

$$\mu = 5.9367084E-005$$

$$Mu = 7.4472E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$cc \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear\_factor} * \text{Max}(\mu, cc) = 0.00514506$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu = 0.00514506$$

$$\mu_e \text{ (5.4c)} = 0.00169139$$

$$\mu_{se} \text{ ((5.4d), TBDY)} = (\mu_{se1} * A_{ext} + \mu_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$\mu_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

$$\mu_{se2} = \text{Max}(\mu_{se1}, \mu_{se2}) = 0.14776895$$

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

$$\mu_{sh, \min} * F_{ywe} = \text{Min}(\mu_{sh, x} * F_{ywe}, \mu_{sh, y} * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for  $\mu_{sh, \min} * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\mu_{sh, x} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 2.25223$$

$$\mu_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

$$\mu_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

$$\mu_{sh, y} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 1.25908$$

$$\mu_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

$$\mu_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$



```

fy1 = 694.45
su1 = 0.032
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/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) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    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

```

$$\begin{aligned} \mu_u &= M_{Rc} (4.15) = 7.4472E+008 \\ u &= s_u (4.1) = 5.9367084E-005 \end{aligned}$$

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:

$$\begin{aligned} u &= 5.6088283E-005 \\ \mu_u &= 4.3734E+008 \end{aligned}$$

with full section properties:

$$\begin{aligned} b &= 400.00 \\ d &= 627.00 \\ d' &= 43.00 \\ v &= 0.00027032 \\ N &= 2237.255 \\ f_c &= 33.00 \\ c_o (5A.5, TBDY) &= 0.002 \\ \text{Final value of } c_u: c_u^* &= \text{shear\_factor} * \text{Max}(c_u, c_c) = 0.00514506 \end{aligned}$$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $c_u = 0.00514506$

we (5.4c) = 0.00169139

ase ((5.4d), TBDY) =  $(ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$

ase1 = 0.14776895

bo\_1 = 340.00

ho\_1 = 610.00

bi2\_1 = 975400.00

ase2 =  $\text{Max}(ase1, ase2) = 0.14776895$

bo\_2 = 192.00

ho\_2 = 492.00

bi2\_2 = 557856.00

$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.25908$

Expression ((5.4d), TBDY) for  $p_{sh,min} * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25223$$

ps1 (external) =  $(A_{sh1} * h1 / s1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$

No stirrups,  $n_{s\_1} = 2.00$

$h1 = 670.00$

ps2 (internal) =  $(A_{sh2} * h2 / s2) / A_{sec} = 0.00062519$

$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$

No stirrups,  $n_{s\_2} = 2.00$

$h2 = 500.00$

$$p_{sh,y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25908$$

ps1 (external) =  $(A_{sh1} * h1 / s1) / A_{sec} = 0.00156298$

$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$

No stirrups,  $n_{s\_1} = 2.00$

$h1 = 400.00$

ps2 (internal) =  $(A_{sh2} * h2 / s2) / A_{sec} = 0.00025008$

$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$

No stirrups,  $n_{s\_2} = 2.00$

$h2 = 200.00$

$A_{sec} = 268000.00$

$s1 = 150.00$

$s2 = 300.00$

$f_{ywe1} = 694.45$

```

fywe2 = 694.45
fce = 33.00
From ((5A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 833.34
fy1 = 694.45
su1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 833.34
fy2 = 694.45
su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 833.34
fyv = 694.45
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value 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) = 0.05957415
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) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
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

--->

$\mu_u(4.9) = 0.09006517$

$\mu_u = M_{Rc}(4.14) = 4.3734E+008$

$u = \mu_u(4.1) = 5.6088283E-005$

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:

$\mu_u = 5.9367084E-005$

$\mu_u = 7.4472E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.00027032$

$N = 2237.255$

$f_c = 33.00$

$\phi_c(5A.5, TBDY) = 0.002$

Final value of  $\phi_{cu}$ :  $\phi_{cu}^* = \text{shear\_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00514506$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $\phi_{cu} = 0.00514506$

$\phi_{we}(5.4c) = 0.00169139$

$\phi_{ase}((5.4d), TBDY) = (\phi_{ase1} * A_{ext} + \phi_{ase2} * A_{int}) / A_{sec} = 0.14776895$

$\phi_{ase1} = 0.14776895$

$\phi_{bo\_1} = 340.00$

$\phi_{ho\_1} = 610.00$

$\phi_{bi2\_1} = 975400.00$

$\phi_{ase2} = \text{Max}(\phi_{ase1}, \phi_{ase2}) = 0.14776895$

$\phi_{bo\_2} = 192.00$

$\phi_{ho\_2} = 492.00$

$\phi_{bi2\_2} = 557856.00$

$\phi_{psh,min} * F_{ywe} = \text{Min}(\phi_{psh,x} * F_{ywe}, \phi_{psh,y} * F_{ywe}) = 1.25908$

Expression ((5.4d), TBDY) for  $\phi_{psh,min} * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$\phi_{psh,x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 2.25223$

$\phi_{ps1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$

No stirrups,  $n_{s\_1} = 2.00$

$h_1 = 670.00$

$\phi_{ps2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$

$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$

No stirrups,  $n_{s\_2} = 2.00$

$h_2 = 500.00$

$\phi_{psh,y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 1.25908$

$\phi_{ps1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$

$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$

No stirrups,  $n_{s\_1} = 2.00$

$h_1 = 400.00$

$\phi_{ps2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$

$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$

No stirrups,  $n_{s\_2} = 2.00$

$h_2 = 200.00$

```

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.0025
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) = 33.00
cc (5A.5, TBDY) = 0.002

```

$c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.13125889$   
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.0736092$   
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.04169017$   
 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  $V_r = \text{Min}(V_{r1}, V_{r2}) = 558200.119$

Calculation of Shear Strength at edge 1,  $V_{r1} = 558200.119$   
 $V_{r1} = V_n((22.5.1.1), \text{ACI } 318-14)$

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f\*Vf'  
 where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
 $= 1$  (normal-weight concrete)  
 Mean concrete strength:  $f'_c = (f'_c_{\text{jacket}}*Area_{\text{jacket}} + f'_c_{\text{core}}*Area_{\text{core}})/Area_{\text{section}} = 33.00$ , but  $f_c^{0.5} \leq 8.3$   
 MPa (22.5.3.1, ACI 318-14)  
 $p_w = A_s/(b_w*d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u*d/M_u < 1 = 1.00$   
 $M_u = 1.0197E+006$   
 $V_u = 9840.632$   
 From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 349068.643$   
 $V_{s1} = 311834.654$  is calculated for jacket, with:  
 $d = 536.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 37233.989$  is calculated for jacket, with:  
 $d_2 = 400.00$   
 $A_v = 100530.965$   
 $f_y = 555.56$   
 $s = 300.00$   
 $V_{s2}$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)  
 $2(1-s/d) = 0.50$   
 $V_f((11-3)-(11.4), \text{ACI } 440) = 0.00$   
 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) 'Vw' is replaced by 'Vw+ f\*Vf'  
 where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
 $= 1$  (normal-weight concrete)

Mean concrete strength:  $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 33.00$ , 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

$bw = 400.00$

$d = 536.00$

$Vu \cdot d / Mu < 1 = 1.00$

$Mu = 1.0197E+006$

$Vu = 9840.634$

From (11.5.4.8), ACI 318-14:  $Vs1 + Vs2 = 349068.643$

$Vs1 = 311834.654$  is calculated for jacket, with:

$d = 536.00$

$Av = 157079.633$

$fy = 555.56$

$s = 150.00$

$Vs1$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17, 10.3.4)

$Vs2 = 37233.989$  is calculated for jacket, with:

$d = 400.00$

$Av = 100530.965$

$fy = 555.56$

$s = 300.00$

$Vs2$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17, 10.3.4)

$2(1-s/d) = 0.50$

$Vf ((11-3)-(11.4), ACI 440) = 0.00$

From (11-11), ACI 440:  $Vs + Vf \leq 818179.336$

-----

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 3

-----

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

-----

Knowledge Factor,  $\phi = 0.85$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength,  $fc = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength,  $fs = f_{sm} = 555.56$

Concrete Elasticity,  $Ec = 26999.444$

Steel Elasticity,  $Es = 200000.00$

Existing Column

New material of Secondary Member: Concrete Strength,  $fc = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength,  $fs = f_{sm} = 555.56$

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,  $fs = 1.25 \cdot f_{sm} = 694.45$

Existing Column

New material: Steel Strength,  $fs = 1.25 \cdot f_{sm} = 694.45$

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length,  $L = 3000.00$

Secondary Member  
Ribbed Bars  
Ductile Steel  
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)  
Longitudinal Bars With Ends Lapped Starting at the End Sections  
Adequate Lap Length ( $l_o/l_{ou}, \min \geq 1$ )  
No FRP Wrapping

#### Stepwise Properties

At local axis: 2  
EDGE -A-  
Shear Force,  $V_a = 1.8202823E-014$   
EDGE -B-  
Shear Force,  $V_b = -1.8202823E-014$   
BOTH EDGES  
Axial Force,  $F = -2237.255$   
Longitudinal Reinforcement Area Distribution (in 2 divisions)  
-Tension:  $As_t = 709.9999$   
-Compression:  $As_c = 1668.186$   
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $As_{t,ten} = 911.0619$   
-Compression:  $As_{c,com} = 911.0619$   
-Middle:  $As_{mid} = 556.0619$

Calculation of Shear Capacity ratio,  $V_e/V_r = 0.53480887$   
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 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 static loading combination  
and  
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$   
with  
 $V_1 = 1.8202823E-014$ , is the shear force acting at edge 1 for the static loading combination  
 $V_2 = -1.8202823E-014$ , 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:  
 $\phi_u = 0.00010406$   
 $\mu_u = 3.0743E+008$

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  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} \cdot \max(\phi_u, \phi_c) = 0.00514506$



The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $c_u = 0.00514506$   
 $w_e$  (5.4c) = 0.00169139  
 $a_{se}$  ((5.4d), TBDY) =  $(a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int}) / A_{sec} = 0.14776895$   
 $a_{se1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $p_{sh,min} \cdot F_{ywe} = \text{Min}(p_{sh,x} \cdot F_{ywe}, p_{sh,y} \cdot F_{ywe}) = 1.25908$   
 Expression ((5.4d), TBDY) for  $p_{sh,min} \cdot F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 2.25223$   
 $p_{s1}$  (external) =  $(A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} \cdot n_{s\_1} = 157.0796$   
 No stirrups,  $n_{s\_1} = 2.00$   
 $h_1 = 670.00$   
 $p_{s2}$  (internal) =  $(A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00062519$   
 $A_{sh2} = A_{stir\_2} \cdot n_{s\_2} = 100.531$   
 No stirrups,  $n_{s\_2} = 2.00$   
 $h_2 = 500.00$

$p_{sh,y} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 1.25908$   
 $p_{s1}$  (external) =  $(A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00156298$   
 $A_{sh1} = A_{stir\_1} \cdot n_{s\_1} = 157.0796$   
 No stirrups,  $n_{s\_1} = 2.00$   
 $h_1 = 400.00$   
 $p_{s2}$  (internal) =  $(A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00025008$   
 $A_{sh2} = A_{stir\_2} \cdot n_{s\_2} = 100.531$   
 No stirrups,  $n_{s\_2} = 2.00$   
 $h_2 = 200.00$

$A_{sec} = 268000.00$   
 $s_1 = 150.00$   
 $s_2 = 300.00$   
 $f_{ywe1} = 694.45$   
 $f_{ywe2} = 694.45$   
 $f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY:  $c_c = 0.002$   
 $c$  = confinement factor = 1.00

$y_1 = 0.0025$   
 $sh_1 = 0.008$   
 $ft_1 = 833.34$   
 $fy_1 = 694.45$   
 $su_1 = 0.032$

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  $fs_1 = (f_{s,jacket} \cdot A_{s,ten,jacket} + f_{s,core} \cdot A_{s,ten,core}) / A_{s,ten} = 694.45$

with  $Es_1 = (E_{s,jacket} \cdot A_{s,ten,jacket} + E_{s,core} \cdot A_{s,ten,core}) / A_{s,ten} = 200000.00$

$y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$   
 $fy_2 = 694.45$   
 $su_2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with

```

Shear_factor = 1.00
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) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
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

$v = 0.00028344$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $\phi_c (5A.5, \text{TB DY}) = 0.002$   
 Final value of  $\phi_c$ :  $\phi_c = \text{shear\_factor} * \text{Max}(\phi_c, \phi_c) = 0.00514506$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TB DY:  $\phi_c = 0.00514506$   
 $\phi_w (5.4c) = 0.00169139$   
 $\phi_{se} ((5.4d), \text{TB DY}) = (\phi_{se1} * A_{ext} + \phi_{se2} * A_{int}) / A_{sec} = 0.14776895$   
 $\phi_{se1} = 0.14776895$   
 $\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$   
 $\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.25908$   
 Expression ((5.4d), TB DY) for  $\phi_{sh, \min} * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.25223$   
 $\phi_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 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.A.5), TB DY), TB DY:  $\phi_c = 0.002$   
 $c = \text{confinement factor} = 1.00$

$y_1 = 0.0025$   
 $sh_1 = 0.008$   
 $ft_1 = 833.34$   
 $fy_1 = 694.45$   
 $su_1 = 0.032$

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

$\phi_{lo/lou, \min} = \phi_b / \phi_d = 1.00$

$su_1 = 0.4 * \phi_{su1\_nominal} ((5.5), \text{TB DY}) = 0.032$

From table 5A.1, TB DY:  $\phi_{su1\_nominal} = 0.08$ ,

For calculation of  $\phi_{su1\_nominal}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered  
 characteristic value  $fs_1 = fs_1 / 1.2$ , from table 5.1, TB DY.

$y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 * (\phi_b / \phi_d)^{2/3})$ , 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/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) = 0.08015524
    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) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    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/lb

Adequate Lap Length: lb/lb >= 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:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$\alpha (5A.5, \text{TB DY}) = 0.002$$

$$\text{Final value of } \alpha: \alpha^* = \text{shear\_factor} * \text{Max}(\alpha, \alpha_c) = 0.00514506$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TB DY: } \alpha_c = 0.00514506$$

$$\alpha_w (5.4c) = 0.00169139$$

$$\alpha_{se} ((5.4d), \text{TB DY}) = (\alpha_{se1} * A_{ext} + \alpha_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$\alpha_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

$$\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.14776895$$

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

$$\text{psh}_{\min} * F_{ywe} = \text{Min}(\text{psh}_x * F_{ywe}, \text{psh}_y * F_{ywe}) = 1.25908$$

Expression ((5.4d), TB DY) for  $\text{psh}_{\min} * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\text{psh}_x * F_{ywe} = \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 2.25223$$

$$\text{ps}_1 (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

$$\text{ps}_2 (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

$$\text{psh}_y * F_{ywe} = \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 1.25908$$

$$\text{ps}_1 (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

$$\text{ps}_2 (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TB DY), TB DY: } \alpha_c = 0.002$$

$$\alpha_c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 833.34$$

$$fy_1 = 694.45$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor

and also multiplied by the shear\_factor according to 15.7.1.4, with

$$\text{Shear\_factor} = 1.00$$

$$l_o / l_{ou, \min} = l_b / l_d = 1.00$$

$$su_1 = 0.4 * esu_{1\_nominal} ((5.5), \text{TB DY}) = 0.032$$

From table 5A.1, TB DY:  $esu_{1\_nominal} = 0.08$ ,

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, TB DY.

$y1, sh1, ft1, fy1$ , 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  
 $lo/lou, min = lb/lb, min = 1.00$   
 $su2 = 0.4 \cdot esu2_{nominal} ((5.5), TBDY) = 0.032$   
 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  
 $lo/lou, min = lb/ld = 1.00$   
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$   
 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  $Es_v = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$   
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.08015524$   
 $2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.08015524$   
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.04892233$   
 and confined core properties:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.09611636$   
 $2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.09611636$   
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.05866412$   
 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  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

$$u = 0.00010406$$

$$Mu = 3.0743E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$\alpha (5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.00514506$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.00514506$$

$$\phi_{ue} \text{ (5.4c)} = 0.00169139$$

$$\phi_{se} \text{ ((5.4d), TBDY)} = (\phi_{se1} * A_{ext} + \phi_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$\phi_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

$$\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$$

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

$$\phi_{sh,min} * F_{ywe} = \text{Min}(\phi_{sh,x} * F_{ywe}, \phi_{sh,y} * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for  $\phi_{sh,min} * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{sh,x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.25223$$

$$\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{sh,y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.25908$$

$$\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$f_{t1} = 833.34$$

$$f_{y1} = 694.45$$

$$s_{u1} = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$l_o/l_{o,min} = l_b/l_d = 1.00$   
 $su_1 = 0.4 \cdot esu_{1,nominal} ((5.5), TBDY) = 0.032$   
 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  $fs_1 = (fs_{jacket} \cdot Asl_{ten,jacket} + fs_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 694.45$   
 with  $Es_1 = (Es_{jacket} \cdot Asl_{ten,jacket} + Es_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 200000.00$   
 $y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$   
 $fy_2 = 694.45$   
 $su_2 = 0.032$   
 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  
 $l_o/l_{o,min} = l_b/l_{b,min} = 1.00$   
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esu_{2,nominal} = 0.08$ ,  
 For calculation of  $esu_{2,nominal}$  and  $y_2, sh_2, ft_2, fy_2$ , it is considered  
 characteristic value  $fsy_2 = fs_2/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , 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  
 $l_o/l_{o,min} = l_b/l_d = 1.00$   
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 694.45$   
 with  $Esv = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$   
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.08015524$   
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.08015524$   
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.04892233$   
 and confined core properties:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.09611636$   
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.09611636$   
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.05866412$   
 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 Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 383231.42$

Calculation of Shear Strength at edge 1,  $V_{r1} = 383231.42$   
 $V_{r1} = V_n$  ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' $V_w$ ' is replaced by ' $V_w + f \cdot V_f$ '  
where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 197061.477$   
 $= 1$  (normal-weight concrete)

Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot \text{Area}_{jacket} + f'_{c\_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$ , but  $f_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$p_w = A_s / (b_w \cdot d) = 0.00331157$

$A_s$  (tension reinf.) = 709.9999

$b_w = 670.00$

$d = 320.00$

$V_u \cdot d / M_u < 1 = 0.00$

$M_u = 4.0861879\text{E-}011$

$V_u = 1.8202823\text{E-}014$

From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$

$V_{s1} = 186169.943$  is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 150.00$

$V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

$V_{s2} = 0.00$  is calculated for jacket, with:

$d_2 = 160.00$

$A_v = 100530.965$

$f_y = 555.56$

$s = 300.00$

$V_{s2}$  is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

$V_f$  ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

Calculation of Shear Strength at edge 2,  $V_{r2} = 383231.42$   
 $V_{r2} = V_n$  ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' $V_w$ ' is replaced by ' $V_w + f \cdot V_f$ '  
where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 197061.477$   
 $= 1$  (normal-weight concrete)

Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot \text{Area}_{jacket} + f'_{c\_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$ , but  $f_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$p_w = A_s / (b_w \cdot d) = 0.00331157$

$A_s$  (tension reinf.) = 709.9999

$b_w = 670.00$

$d = 320.00$

$V_u \cdot d / M_u < 1 = 0.00$

$M_u = 1.3749363\text{E-}011$

$V_u = 1.8202823\text{E-}014$

From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$

$V_{s1} = 186169.943$  is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 150.00$

$V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

$V_{s2} = 0.00$  is calculated for jacket, with:

$d = 160.00$

$A_v = 100530.965$

$f_y = 555.56$

s = 300.00

Vs2 is considered 0 (s>d, according to ASCE 41-17,10.3.4)

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: Vs + Vf <= 818179.336

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\phi = 0.85$

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Secondary 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 Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Secondary 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,  $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ( $l_b/l_d > 1$ )

No FRP Wrapping

Stepwise Properties

Bending Moment,  $M = 6.8008E+006$

Shear Force,  $V_2 = -1.6099959E-014$

Shear Force,  $V_3 = 4020.286$

Axial Force,  $F = -3615.026$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $As_t = 709.9999$

-Compression:  $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{t,ten} = 709.9999$

-Compression:  $As_{l,com} = 1266.062$

-Middle:  $As_{l,mid} = 402.1239$

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{l,ten,jacket} = 402.1239$

-Compression:  $As_{l,com,jacket} = 804.2477$

-Middle:  $As_{l,mid,jacket} = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{l,ten,core} = 307.8761$

-Compression:  $As_{l,com,core} = 461.8141$

-Middle:  $Asl_{mid,core} = 0.00$

Mean Diameter of Tension Reinforcement,  $DbL = 15.00$

New component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u_R = 1.0^*$   $u = 0.05189937$   
 $u = y + p = 0.05189937$

- Calculation of  $y$  -

$y = (My * Ls / 3) / Eleff = 0.00189937$  ((4.29), Biskinis Phd))  
 $My = 2.7353E+008$   
 $Ls = M/V$  (with  $Ls > 0.1 * L$  and  $Ls < 2 * L$ ) = 1691.609  
From table 10.5, ASCE 41\_17:  $Eleff = 0.3 * Ec * Ig = 8.1204E+013$

Calculation of Yielding Moment  $My$

Calculation of  $y$  and  $My$  according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$   
 $y_{ten} = 5.4341293E-006$   
with  $fy = 555.56$   
 $d = 627.00$   
 $y = 0.18472625$   
 $A = 0.00950834$   
 $B = 0.00405975$   
with  $pt = 0.00283094$   
 $pc = 0.00504809$   
 $pv = 0.00160336$   
 $N = 3615.026$   
 $b = 400.00$   
 $" = 0.06858054$   
 $y_{comp} = 1.9040135E-005$   
with  $fc = 33.00$   
 $Ec = 26999.444$   
 $y = 0.18428672$   
 $A = 0.00944964$   
 $B = 0.0040338$   
with  $Es = 200000.00$

Calculation of ratio  $lb/d$

Adequate Lap Length:  $lb/d \geq 1$

- Calculation of  $p$  -

From table 10-7:  $p = 0.05$

with:

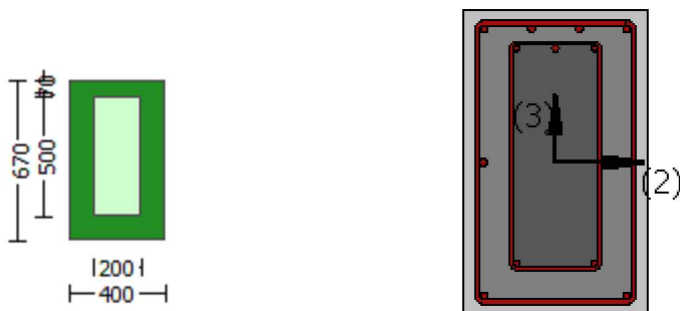
- Condition i occurred  
Beam controlled by flexure:  $Vp/Vo \leq 1$   
shear control ratio  $Vp/Vo = 0.90705729$
- Transverse Reinforcement: C
- Stirrup Spacing  $\leq d/3$
- Low ductility demand,  $y < 2$  (table 10-6, ASCE 41-17)  
 $= 4.7228346E-005$
- Stirrup Spacing  $\leq d/2$   
 $d = d_{external} = 627.00$   
 $s = s_{external} = 150.00$
- Strength provided by hoops  $Vs < 3/4 * \text{design Shear}$   
 $Vs = 386302.632$ , already given in calculation of shear control ratio  
design Shear = 4020.286

$-( - ')/ bal = -0.22420649$   
 $= Aslt/(bw*d) = 0.00283094$   
 Tension Reinf Area:  $Aslt = 709.9999$   
 $' = Aslc/(bw*d) = 0.00665146$   
 Compression Reinf Area:  $Aslc = 1668.186$   
 From (B-1), ACI 318-11:  $bal = 0.01704017$   
 $fc = (fc\_jacket*Area\_jacket+fc\_core*Area\_core)/section\_area = 33.00$   
 $fy = fy\_jacket\_bars = 555.56$   
 From 10.2.7.3, ACI 318-11:  $\lambda = 0.65$   
 From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000/(87000+ fy) = cb/dt = 0.003/(0.003+ y) = 0.51922877$   
 $y = 0.0027778$   
 $- V/(bw*d*fc^{0.5}) = 0.03360437$ , 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. 11

beam B1, Floor 1  
 Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)  
 Analysis: Uniform +X  
 Check: Shear capacity VRd  
 Edge: Start  
 Local Axis: (3)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1  
 At local axis: 3  
 Integration Section: (a)  
 Section Type: rcjars

Constant Properties

-----  
 Knowledge Factor,  $\gamma = 0.85$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Secondary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Secondary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Secondary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Secondary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

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,  $V_a = 4020.286$

EDGE -B-

Bending Moment,  $M_b = 1.0660E+007$

Shear Force,  $V_b = 15660.98$

BOTH EDGES

Axial Force,  $F = -3615.026$

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:  $As_{l,mid} = 402.1239$

Mean Diameter of Tension Reinforcement,  $Db_{L,ten} = 15.00$

New component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $VR = 1.0 \cdot V_n = 489503.742$

$V_n$  ((22.5.1.1), ACI 318-14) = 489503.742

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:  $V_c = 175344.476$

= 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

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / M_u < 1 = 0.31685806$

$M_u = 6.8008E+006$

$V_u = 4020.286$

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

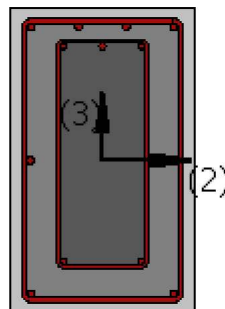
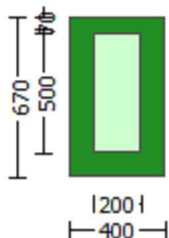
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (  $\mu$  )

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 0.85$   
Mean strength values are used for both shear and moment calculations.  
Consequently:  
Jacket  
New material of Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$   
New material of Secondary 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 Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$   
New material of Secondary Member: Steel Strength,  $f_s = f_{sm} = 555.56$   
Concrete Elasticity,  $E_c = 26999.444$   
Steel Elasticity,  $E_s = 200000.00$   
#####  
Note: Especially for the calculation of moment strengths,  
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14  
Jacket  
New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$   
Existing Column  
New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$   
#####  
External Height,  $H = 670.00$   
External Width,  $W = 400.00$   
Internal Height,  $H = 500.00$   
Internal Width,  $W = 200.00$   
Cover Thickness,  $c = 25.00$   
Mean Confinement Factor overall section = 1.00  
Element Length,  $L = 3000.00$   
Secondary Member  
Ribbed Bars  
Ductile Steel  
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)  
Longitudinal Bars With Ends Lapped Starting at the End Sections  
Adequate Lap Length ( $l_o/l_{ou,min} \geq 1$ )  
No FRP Wrapping

#### Stepwise Properties

At local axis: 3  
EDGE -A-  
Shear Force,  $V_a = 9840.632$   
EDGE -B-  
Shear Force,  $V_b = 9840.634$   
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  
 $M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 7.4472E+008$   
 $M_{u1+} = 4.3734E+008$ , is the ultimate moment strength at the edge 1 of the member in the actual moment direction  
which is defined for the static loading combination  
 $M_{u1-} = 7.4472E+008$ , is the ultimate moment strength at the edge 1 of the member in the opposite moment  
direction which is defined for the static loading combination  
 $M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 7.4472E+008$

$Mu_{2+} = 4.3734E+008$ , 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

$$\pm wu*ln = (|V1| + |V2|)/2$$

with

$V1 = 9840.632$ , is the shear force acting at edge 1 for the the static loading combination

$V2 = 9840.634$ , is the shear force acting at edge 2 for the the static loading combination

-----  
Calculation of  $Mu_{1+}$   
-----

-----  
Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:

$$u = 5.6088283E-005$$

$$Mu = 4.3734E+008$$

-----  
with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$co(5A.5, TBDY) = 0.002$$

$$\text{Final value of } cu: cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00514506$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } cu = 0.00514506$$

$$we(5.4c) = 0.00169139$$

$$ase((5.4d), TBDY) = (ase1*Aext + ase2*Aint)/Asec = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo\_1 = 340.00$$

$$ho\_1 = 610.00$$

$$bi2\_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo\_2 = 192.00$$

$$ho\_2 = 492.00$$

$$bi2\_2 = 557856.00$$

$$psh, \min * Fywe = \text{Min}(psh, x * Fywe, psh, y * Fywe) = 1.25908$$

Expression ((5.4d), TBDY) for  $psh, \min * Fywe$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$psh\_x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 2.25223$$

$$ps1(\text{external}) = (Ash1 * h1 / s1) / Asec = 0.00261799$$

$$Ash1 = Astir\_1 * ns\_1 = 157.0796$$

$$\text{No stirrups, } ns\_1 = 2.00$$

$$h1 = 670.00$$

$$ps2(\text{internal}) = (Ash2 * h2 / s2) / Asec = 0.00062519$$

$$Ash2 = Astir\_2 * ns\_2 = 100.531$$

$$\text{No stirrups, } ns\_2 = 2.00$$

$$h2 = 500.00$$

$$psh\_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.25908$$

$$ps1(\text{external}) = (Ash1 * h1 / s1) / Asec = 0.00156298$$

$$Ash1 = Astir\_1 * ns\_1 = 157.0796$$

$$\text{No stirrups, } ns\_1 = 2.00$$

$$h1 = 400.00$$

$$ps2(\text{internal}) = (Ash2 * h2 / s2) / Asec = 0.00025008$$

$$Ash2 = Astir\_2 * ns\_2 = 100.531$$

$$\text{No stirrups, } ns\_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$



```

fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 833.34
fy1 = 694.45
su1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$ , 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  $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$ , from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 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  $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$ , from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 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) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
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)

--->

$v < v_{s,y2}$  - 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  $\mu_{u1}$ -

Calculation of ultimate curvature  $\mu_u$  according to 4.1, Biskinis/Fardis 2013:

$u = 5.9367084E-005$

$M_u = 7.4472E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.00027032$

$N = 2237.255$

$f_c = 33.00$

$\phi_c$  (5A.5, TBDY) = 0.002

Final value of  $\phi_{cu}$ :  $\phi_{cu}^* = \text{shear\_factor} * \text{Max}(\phi_{cu}, \phi_c) = 0.00514506$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $\phi_{cu} = 0.00514506$

$\phi_{we}$  (5.4c) = 0.00169139

$a_{se}$  ((5.4d), TBDY) =  $(a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o,1} = 340.00$

$h_{o,1} = 610.00$

$b_{i2,1} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o,2} = 192.00$

$h_{o,2} = 492.00$

$b_{i2,2} = 557856.00$

$\phi_{sh,min} * F_{ywe} = \text{Min}(\phi_{sh,x} * F_{ywe}, \phi_{sh,y} * F_{ywe}) = 1.25908$

Expression ((5.4d), TBDY) for  $\phi_{sh,min} * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$\phi_{sh,x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.25223$

$\phi_{s1}$  (external) =  $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir,1} * n_{s,1} = 157.0796$

No stirrups,  $n_{s,1} = 2.00$

$h_1 = 670.00$

$\phi_{s2}$  (internal) =  $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$

$A_{sh2} = A_{stir,2} * n_{s,2} = 100.531$

No stirrups,  $n_{s,2} = 2.00$

$h_2 = 500.00$

$\phi_{sh,y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.25908$

$\phi_{s1}$  (external) =  $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$

$A_{sh1} = A_{stir,1} * n_{s,1} = 157.0796$

No stirrups,  $n_{s,1} = 2.00$

$h_1 = 400.00$

$\phi_{s2}$  (internal) =  $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$

$A_{sh2} = A_{stir,2} * n_{s,2} = 100.531$

No stirrups,  $n_{s,2} = 2.00$

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From } ((5.5), \text{TB DY}), \text{TB DY: } c c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 833.34$$

$$fy1 = 694.45$$

$$su1 = 0.032$$

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

$$lo/lou,min = lb/ld = 1.00$$

$$su1 = 0.4 * esu1\_nominal ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu1\_nominal = 0.08,$$

For calculation of esu1\_nominal and y1, sh1,ft1,fy1, it is considered  
characteristic value fsy1 = fs1/1.2, from table 5.1, TB DY.

$$y1, sh1,ft1,fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs1 = (fs,jacket * Asl,ten,jacket + fs,core * Asl,ten,core) / Asl,ten = 694.45$$

$$\text{with } Es1 = (Es,jacket * Asl,ten,jacket + Es,core * Asl,ten,core) / Asl,ten = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 833.34$$

$$fy2 = 694.45$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou,min = lb/lb,min = 1.00$$

$$su2 = 0.4 * esu2\_nominal ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu2\_nominal = 0.08,$$

For calculation of esu2\_nominal and y2, sh2,ft2,fy2, it is considered  
characteristic value fsy2 = fs2/1.2, from table 5.1, TB DY.

$$y1, sh1,ft1,fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs2 = (fs,jacket * Asl,com,jacket + fs,core * Asl,com,core) / Asl,com = 694.45$$

$$\text{with } Es2 = (Es,jacket * Asl,com,jacket + Es,core * Asl,com,core) / Asl,com = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 833.34$$

$$fyv = 694.45$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou,min = lb/ld = 1.00$$

$$suv = 0.4 * esuv\_nominal ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esuv\_nominal = 0.08,$$

considering characteristic value fsyv = fsv/1.2, from table 5.1, TB DY

For calculation of esuv\_nominal and yv, shv,ftv,fyv, it is considered  
characteristic value fsyv = fsv/1.2, from table 5.1, TB DY.

$$y1, sh1,ft1,fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fsv = (fs,jacket * Asl,mid,jacket + fs,mid * Asl,mid,core) / Asl,mid = 694.45$$

$$\text{with } Esv = (Es,jacket * Asl,mid,jacket + Es,mid * Asl,mid,core) / Asl,mid = 200000.00$$

$$1 = Asl,ten / (b * d) * (fs1 / fc) = 0.10623177$$

$$2 = Asl,com / (b * d) * (fs2 / fc) = 0.05957415$$

$$v = Asl,mid / (b * d) * (fsv / fc) = 0.03374111$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, \text{TB DY}) = 33.00$$

```

cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
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
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00514506
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00514506
we (5.4c) = 0.00169139
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.25908
Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

```

```

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25223
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

```

```

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25908

```

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$$

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$$

$$Ash2 = Astir_2 \cdot ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 694.45$$

$$fce = 33.00$$

$$\text{From } ((5A5), \text{TB DY}), \text{TB DY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 833.34$$

$$fy1 = 694.45$$

$$su1 = 0.032$$

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

$$lo/lou, \min = lb/ld = 1.00$$

$$su1 = 0.4 \cdot esu1_{\text{nominal}} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu1_{\text{nominal}} = 0.08,$$

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.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs1 = (fs_{\text{jacket}} \cdot Asl, \text{ten, jacket} + fs_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 694.45$$

$$\text{with } Es1 = (Es_{\text{jacket}} \cdot Asl, \text{ten, jacket} + Es_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 833.34$$

$$fy2 = 694.45$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 1.00$$

$$su2 = 0.4 \cdot esu2_{\text{nominal}} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu2_{\text{nominal}} = 0.08,$$

For calculation of  $esu2_{\text{nominal}}$  and  $y2, sh2, ft2, fy2$ , it is considered  
characteristic value  $fsy2 = fs2/1.2$ , from table 5.1, TB DY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs2 = (fs_{\text{jacket}} \cdot Asl, \text{com, jacket} + fs_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 694.45$$

$$\text{with } Es2 = (Es_{\text{jacket}} \cdot Asl, \text{com, jacket} + Es_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 833.34$$

$$fyv = 694.45$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$suv = 0.4 \cdot esuv_{\text{nominal}} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esuv_{\text{nominal}} = 0.08,$$

considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TB DY

For calculation of  $esuv_{\text{nominal}}$  and  $yv, shv, ftv, fyv$ , it is considered  
characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TB DY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fsv = (fs_{\text{jacket}} \cdot Asl, \text{mid, jacket} + fs_{\text{mid}} \cdot Asl, \text{mid, core}) / Asl, \text{mid} = 694.45$$

$$\text{with } Esv = (Es_{\text{jacket}} \cdot Asl, \text{mid, jacket} + Es_{\text{mid}} \cdot Asl, \text{mid, core}) / Asl, \text{mid} = 200000.00$$

$$1 = Asl, \text{ten} / (b \cdot d) \cdot (fs1 / fce) = 0.05957415$$

$2 = A_{sl,com}/(b*d)*(f_s2/f_c) = 0.10623177$   
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.03374111$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.0736092$   
 $2 = A_{sl,com}/(b*d)*(f_s2/f_c) = 0.13125889$   
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.04169017$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)

--->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.09006517$   
 $Mu = M_{Rc} (4.14) = 4.3734E+008$   
 $u = su (4.1) = 5.6088283E-005$

Calculation of ratio  $l_b/d$

Adequate Lap Length:  $l_b/d \geq 1$

Calculation of  $Mu_2$ -

Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:  
 $u = 5.9367084E-005$   
 $Mu = 7.4472E+008$

with full section properties:

$b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $co (5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00514506$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00514506$   
 $we (5.4c) = 0.00169139$   
 $ase ((5.4d), TBDY) = (ase1*A_{ext} + ase2*A_{int})/A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo\_1 = 340.00$   
 $ho\_1 = 610.00$   
 $bi2\_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$   
 $psh,min*F_{ywe} = \text{Min}(psh,x*F_{ywe}, psh,y*F_{ywe}) = 1.25908$   
 Expression ((5.4d), TBDY) for  $psh,min*F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh\_x*F_{ywe} = psh1*F_{ywe1} + ps2*F_{ywe2} = 2.25223$   
 $ps1 (\text{external}) = (A_{sh1}*h1/s1)/A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1}*ns\_1 = 157.0796$   
 No stirrups,  $ns\_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 (\text{internal}) = (A_{sh2}*h2/s2)/A_{sec} = 0.00062519$

Ash2 = Astir\_2\*ns\_2 = 100.531  
 No stirups, ns\_2 = 2.00  
 h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
 ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00156298  
 Ash1 = Astir\_1\*ns\_1 = 157.0796  
 No stirups, ns\_1 = 2.00  
 h1 = 400.00  
 ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00025008  
 Ash2 = Astir\_2\*ns\_2 = 100.531  
 No stirups, ns\_2 = 2.00  
 h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 833.34

fy1 = 694.45

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00

lo/lou,min = lb/lb = 1.00

su1 = 0.4\*esu1\_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1\_nominal = 0.08,

For calculation of esu1\_nominal and y1, sh1,ft1,fy1, it is considered  
 characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$ , 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  $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$ , from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket\*Asl,com,jacket + fs,core\*Asl,com,core)/Asl,com = 694.45

with Es2 = (Es,jacket\*Asl,com,jacket + Es,core\*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 833.34

fyv = 694.45

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00

lo/lou,min = lb/lb = 1.00

suv = 0.4\*esuv\_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv\_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY  
 For calculation of esuv\_nominal and yv, shv,ftv,fyv, it is considered

characteristic value  $f_{sv} = f_{sv}/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , 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  $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.10623177$   
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.05957415$   
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.03374111$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} \text{ (5A.2, TBDY)} = 33.00$   
 $cc \text{ (5A.5, TBDY)} = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.13125889$   
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.0736092$   
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.04169017$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is not satisfied  
 --->  
 $v < v_{s,c}$  - RHS eq.(4.5) is satisfied  
 --->  
 $su \text{ (4.8)} = 0.1403202$   
 $Mu = MR_c \text{ (4.15)} = 7.4472E+008$   
 $u = su \text{ (4.1)} = 5.9367084E-005$   
 -----  
 Calculation of ratio  $l_b/l_d$   
 -----  
 Adequate Lap Length:  $l_b/l_d \geq 1$   
 -----  
 -----  
 Calculation of Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 558200.119$   
 -----  
 Calculation of Shear Strength at edge 1,  $V_{r1} = 558200.119$   
 $V_{r1} = V_n \text{ ((22.5.1.1), ACI 318-14)}$   
 -----  
 NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f\*Vf'  
 where Vf is the contribution of FRPs (11.3), ACI 440).  
 -----  
 From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
 $= 1$  (normal-weight concrete)  
 Mean concrete strength:  $f'_c = (f'_{c,jacket} \cdot \text{Area}_{jacket} + f'_{c,core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$ , but  $f'_c \cdot 0.5 \leq 8.3$   
 MPa (22.5.3.1, ACI 318-14)  
 $p_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s \text{ (tension reinf.)} = 709.9999$   
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / Mu < 1 = 1.00$   
 $Mu = 1.0197E+006$   
 $V_u = 9840.632$   
 From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 349068.643$   
 $V_{s1} = 311834.654$  is calculated for jacket, with:  
 $d = 536.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17, 10.3.4)  
 $V_{s2} = 37233.989$  is calculated for jacket, with:  
 $d_2 = 400.00$   
 $A_v = 100530.965$   
 $f_y = 555.56$   
 $s = 300.00$



Vs2 has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$$V_f((11-3)-(11.4), \text{ACI 440}) = 0.00$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 818179.336$$

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) 'Vw' is replaced by 'Vw + f\*Vf' where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$   
= 1 (normal-weight concrete)

Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot \text{Area}_{jacket} + f'_{c\_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$ , but  $f_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$$p_w = A_s / (b_w \cdot d) = 0.00331157$$

$$A_s (\text{tension reinf.}) = 709.9999$$

$$b_w = 400.00$$

$$d = 536.00$$

$$V_u \cdot d / M_u < 1 = 1.00$$

$$M_u = 1.0197E+006$$

$$V_u = 9840.634$$

From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 349068.643$

$V_{s1} = 311834.654$  is calculated for jacket, with:

$$d = 536.00$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

$V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

$V_{s2} = 37233.989$  is calculated for jacket, with:

$$d = 400.00$$

$$A_v = 100530.965$$

$$f_y = 555.56$$

$$s = 300.00$$

$V_{s2}$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$$V_f((11-3)-(11.4), \text{ACI 440}) = 0.00$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 818179.336$$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1  
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\phi = 0.85$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Secondary 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 Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

```

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$ 
Existing Column
New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$ 
#####
External Height,  $H = 670.00$ 
External Width,  $W = 400.00$ 
Internal Height,  $H = 500.00$ 
Internal Width,  $W = 200.00$ 
Cover Thickness,  $c = 25.00$ 
Mean Confinement Factor overall section = 1.00
Element Length,  $L = 3000.00$ 
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ( $l_o/l_{ou}, \min > 1$ )
No FRP Wrapping
-----

Stepwise Properties
-----
At local axis: 2
EDGE -A-
Shear Force,  $V_a = 1.8202823E-014$ 
EDGE -B-
Shear Force,  $V_b = -1.8202823E-014$ 
BOTH EDGES
Axial Force,  $F = -2237.255$ 
Longitudinal Reinforcement Area Distribution (in 2 divisions)
  -Tension:  $A_{st} = 709.9999$ 
  -Compression:  $A_{sc} = 1668.186$ 
Longitudinal Reinforcement Area Distribution (in 3 divisions)
  -Tension:  $A_{st,ten} = 911.0619$ 
  -Compression:  $A_{st,com} = 911.0619$ 
  -Middle:  $A_{st,mid} = 556.0619$ 
-----
-----

Calculation of Shear Capacity ratio ,  $V_e/V_r = 0.53480887$ 
Member Controlled by Flexure ( $V_e/V_r < 1$ )
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 204955.561$ 
with
 $M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 3.0743E+008$ 
   $M_{u1+} = 3.0743E+008$ , is the ultimate moment strength at the edge 1 of the member in the actual moment direction
  which is defined for the static loading combination
   $M_{u1-} = 3.0743E+008$ , is the ultimate moment strength at the edge 1 of the member in the opposite moment
  direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 3.0743E+008$ 
   $M_{u2+} = 3.0743E+008$ , is the ultimate moment strength at the edge 2 of the member in the actual moment direction
  which is defined for the the static loading combination
   $M_{u2-} = 3.0743E+008$ , is the ultimate moment strength at the edge 2 of the member in the opposite moment
  direction which is defined for the the static loading combination
and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$ 
with
   $V_1 = 1.8202823E-014$ , is the shear force acting at edge 1 for the the static loading combination
   $V_2 = -1.8202823E-014$ , is the shear force acting at edge 2 for the the static loading combination

-----
Calculation of  $M_{u1+}$ 
-----
-----

```

Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

$$\phi_u = 0.00010406$$

$$M_u = 3.0743E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$\omega (5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.00514506$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.00514506$$

$$\phi_{ue} (5.4c) = 0.00169139$$

$$a_{se} ((5.4d), \text{TBDY}) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

$$\phi_{sh,min} * F_{ywe} = \text{Min}(\phi_{sh,x} * F_{ywe}, \phi_{sh,y} * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for  $\phi_{sh,min} * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{sh,x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.25223$$

$$\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{sh,y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.25908$$

$$\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$f_{t1} = 833.34$$

$$f_{y1} = 694.45$$

$$su_1 = 0.032$$

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

$$l_o / l_{ou,min} = l_b / l_d = 1.00$$

$$su_1 = 0.4 * esu_{1,nominal} ((5.5), \text{TBDY}) = 0.032$$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,  
For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered characteristic value  $fsy1 = fs1/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25 \cdot (lb/ld)^{2/3})$ , 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  $Min(1, 1.25 \cdot (lb/ld)^{2/3})$ , 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  $Min(1, 1.25 \cdot (lb/ld)^{2/3})$ , 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  $Es_v = (Es\_jacket \cdot Asl\_mid\_jacket + Es\_mid \cdot Asl\_mid\_core) / Asl\_mid = 200000.00$   
 $1 = Asl\_ten / (b \cdot d) \cdot (fs1 / fc) = 0.08015524$   
 $2 = Asl\_com / (b \cdot d) \cdot (fs2 / fc) = 0.08015524$   
 $v = Asl\_mid / (b \cdot d) \cdot (fsv / fc) = 0.04892233$   
and confined core properties:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc$  (5A.2, TBDY) = 33.00  
 $cc$  (5A.5, TBDY) = 0.002  
 $c$  = confinement factor = 1.00  
 $1 = Asl\_ten / (b \cdot d) \cdot (fs1 / fc) = 0.09611636$   
 $2 = Asl\_com / (b \cdot d) \cdot (fs2 / fc) = 0.09611636$   
 $v = Asl\_mid / (b \cdot d) \cdot (fsv / fc) = 0.05866412$   
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 Mu1-

Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:

$$\mu = 0.00010406$$

$$Mu = 3.0743E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$cc(5A.5, TBDY) = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear\_factor} * \text{Max}(\mu_c, \mu_{cc}) = 0.00514506$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu_c = 0.00514506$$

$$\mu_{cc}(5.4c) = 0.00169139$$

$$ase((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

$$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for  $psh_{min} * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25223$$

$$ps1(\text{external}) = (Ash1 * h1 / s1) / A_{sec} = 0.00261799$$

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2(\text{internal}) = (Ash2 * h2 / s2) / A_{sec} = 0.00062519$$

$$Ash2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25908$$

$$ps1(\text{external}) = (Ash1 * h1 / s1) / A_{sec} = 0.00156298$$

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2(\text{internal}) = (Ash2 * h2 / s2) / A_{sec} = 0.00025008$$

$$Ash2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 833.34$$

$$fy1 = 694.45$$

$$su1 = 0.032$$

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  
 $l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $su_1 = 0.4 \cdot esu_{1,nominal} ((5.5), TBDY) = 0.032$   
 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  $fs_1 = (f_{s,jacket} \cdot A_{s,ten,jacket} + f_{s,core} \cdot A_{s,ten,core}) / A_{s,ten} = 694.45$   
 with  $Es_1 = (E_{s,jacket} \cdot A_{s,ten,jacket} + E_{s,core} \cdot A_{s,ten,core}) / A_{s,ten} = 200000.00$   
 $y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$   
 $fy_2 = 694.45$   
 $su_2 = 0.032$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $l_o/l_{ou,min} = l_b/l_{b,min} = 1.00$   
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$   
 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.  
 $y_2, sh_2, ft_2, fy_2$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_2 = (f_{s,jacket} \cdot A_{s,com,jacket} + f_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 694.45$   
 with  $Es_2 = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 200000.00$   
 $y_v = 0.0025$   
 $sh_v = 0.008$   
 $ft_v = 833.34$   
 $fy_v = 694.45$   
 $suv = 0.032$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fsyv = f_{sv}/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fsyv = f_{sv}/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 694.45$   
 with  $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.08015524$   
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.08015524$   
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.04892233$   
 and confined core properties:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.09611636$   
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.09611636$   
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.05866412$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' does not satisfy Eq. (4.3)  
 --->  
 $v < v_{s,c}$  - RHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.13857861$   
 $Mu = MRc (4.14) = 3.0743E+008$   
 $u = su (4.1) = 0.00010406$

Calculation of ratio  $l_b/l_d$

Adequate Lap Length:  $l_b/l_d \geq 1$

Calculation of  $\mu_{2+}$

Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:

$$\mu = 0.00010406$$

$$\mu_u = 3.0743E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu_u: \mu_u^* = \text{shear\_factor} * \text{Max}(\mu_u, c_o) = 0.00514506$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu_u = 0.00514506$$

$$\mu_{ue} \text{ (5.4c)} = 0.00169139$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

$$\mu_{sh,min} * F_{ywe} = \text{Min}(\mu_{sh,x} * F_{ywe}, \mu_{sh,y} * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for  $\mu_{sh,min} * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\mu_{sh,x} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 2.25223$$

$$\mu_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

$$\mu_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

$$\mu_{sh,y} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 1.25908$$

$$\mu_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

$$\mu_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

```

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) = 0.08015524
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) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09611636
2 = Asl,com/(b*d)*(fs2/fc) = 0.09611636
v = Asl,mid/(b*d)*(fsv/fc) = 0.05866412
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
---->
v < vs,c - RHS eq.(4.5) is satisfied
---->

```



su (4.9) = 0.13857861  
Mu = MRc (4.14) = 3.0743E+008  
u = su (4.1) = 0.00010406

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu2-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 0.00010406  
Mu = 3.0743E+008

with full section properties:

b = 670.00  
d = 357.00  
d' = 43.00  
v = 0.00028344  
N = 2237.255  
fc = 33.00  
co (5A.5, TBDY) = 0.002  
Final value of cu: cu\* = shear\_factor \* Max( cu, cc) = 0.00514506  
The Shear\_factor is considered equal to 1 (pure moment strength)  
From (5.4b), TBDY: cu = 0.00514506  
we (5.4c) = 0.00169139  
ase ((5.4d), TBDY) = (ase1\*Aext+ase2\*Aint)/Asec = 0.14776895  
ase1 = 0.14776895  
bo\_1 = 340.00  
ho\_1 = 610.00  
bi2\_1 = 975400.00  
ase2 = Max(ase1,ase2) = 0.14776895  
bo\_2 = 192.00  
ho\_2 = 492.00  
bi2\_2 = 557856.00  
psh,min\*Fywe = Min(psh,x\*Fywe , psh,y\*Fywe) = 1.25908  
Expression ((5.4d), TBDY) for psh,min\*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh\_x\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 2.25223  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00261799  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirrups, ns\_1 = 2.00  
h1 = 670.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00062519  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirrups, ns\_2 = 2.00  
h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00156298  
Ash1 = Astir\_1\*ns\_1 = 157.0796  
No stirrups, ns\_1 = 2.00  
h1 = 400.00  
ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00025008  
Ash2 = Astir\_2\*ns\_2 = 100.531  
No stirrups, ns\_2 = 2.00  
h2 = 200.00

Asec = 268000.00  
s1 = 150.00  
s2 = 300.00

```

fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
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) = 0.08015524
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) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
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

--->

$s_u$  (4.9) = 0.13857861

$M_u = M_{Rc}$  (4.14) = 3.0743E+008

$u = s_u$  (4.1) = 0.00010406

Calculation of ratio  $l_b/l_d$

Adequate Lap Length:  $l_b/l_d \geq 1$

Calculation of Shear Strength  $V_r = \min(V_{r1}, V_{r2}) = 383231.42$

Calculation of Shear Strength at edge 1,  $V_{r1} = 383231.42$

$V_{r1} = V_n$  ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' $V_w$ ' is replaced by ' $V_w + f_v V_f$ '  
where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 197061.477$

= 1 (normal-weight concrete)

Mean concrete strength:  $f'_c = (f'_{c,jacket} \cdot Area_{jacket} + f'_{c,core} \cdot Area_{core}) / Area_{section} = 33.00$ , but  $f_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)

$p_w = A_s / (b_w \cdot d) = 0.00331157$

$A_s$  (tension reinf.) = 709.9999

$b_w = 670.00$

$d = 320.00$

$V_u \cdot d / M_u < 1 = 0.00$

$M_u = 4.0861879E-011$

$V_u = 1.8202823E-014$

From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$

$V_{s1} = 186169.943$  is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 150.00$

$V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

$V_{s2} = 0.00$  is calculated for jacket, with:

$d_2 = 160.00$

$A_v = 100530.965$

$f_y = 555.56$

$s = 300.00$

$V_{s2}$  is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

$V_f$  ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

Calculation of Shear Strength at edge 2,  $V_{r2} = 383231.42$

$V_{r2} = V_n$  ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' $V_w$ ' is replaced by ' $V_w + f_v V_f$ '  
where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 197061.477$

= 1 (normal-weight concrete)

Mean concrete strength:  $f'_c = (f'_{c,jacket} \cdot Area_{jacket} + f'_{c,core} \cdot Area_{core}) / Area_{section} = 33.00$ , but  $f_c^{0.5} \leq 8.3$   
MPa (22.5.3.1, ACI 318-14)

$p_w = A_s / (b_w \cdot d) = 0.00331157$

$A_s$  (tension reinf.) = 709.9999

$b_w = 670.00$

$d = 320.00$

$V_u \cdot d / M_u < 1 = 0.00$

$$\mu_u = 1.3749363E-011$$

$$\nu_u = 1.8202823E-014$$

From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$

$V_{s1} = 186169.943$  is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

$V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17, 10.3.4)

$V_{s2} = 0.00$  is calculated for jacket, with:

$$d = 160.00$$

$$A_v = 100530.965$$

$$f_y = 555.56$$

$$s = 300.00$$

$V_{s2}$  is considered 0 ( $s > d$ , according to ASCE 41-17, 10.3.4)

$$V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 818179.336$$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\phi = 0.85$

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Secondary 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 Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Secondary 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,  $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ( $l_b/d \geq 1$ )

No FRP Wrapping

Stepwise Properties

Bending Moment,  $M = -2.3875458E-011$

Shear Force,  $V_2 = -1.6099959E-014$

Shear Force,  $V_3 = 4020.286$

Axial Force,  $F = -3615.026$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $As_{lt} = 709.9999$   
 -Compression:  $As_{lc} = 1668.186$   
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
 -Tension:  $As_{l,ten} = 911.0619$   
 -Compression:  $As_{l,com} = 911.0619$   
 -Middle:  $As_{l,mid} = 556.0619$   
 Longitudinal External Reinforcement Area Distribution (in 3 divisions)  
 -Tension:  $As_{l,ten,jacket} = 603.1858$   
 -Compression:  $As_{l,com,jacket} = 603.1858$   
 -Middle:  $As_{l,mid,jacket} = 402.1239$   
 Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)  
 -Tension:  $As_{l,ten,core} = 307.8761$   
 -Compression:  $As_{l,com,core} = 307.8761$   
 -Middle:  $As_{l,mid,core} = 153.938$   
 Mean Diameter of Tension Reinforcement,  $DbL = 15.20$

New component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u_R = 1.0^*$   $u = 0.03344037$   
 $u = y + p = 0.03344037$

- Calculation of  $y$  -

$y = (M_y * L_s / 3) / E_{eff} = 0.00344037$  ((4.29), Biskinis Phd))  
 $M_y = 1.9915E+008$   
 $L_s = M/V$  (with  $L_s > 0.1 * L$  and  $L_s < 2 * L$ ) = 1500.00  
 From table 10.5, ASCE 41\_17:  $E_{eff} = 0.3 * E_c * I_g = 2.8943E+013$

Calculation of Yielding Moment  $M_y$

Calculation of  $y$  and  $M_y$  according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$   
 $y_{ten} = 1.0019692E-005$   
 with  $f_y = 555.56$   
 $d = 357.00$   
 $y = 0.223434$   
 $A = 0.00996987$   
 $B = 0.00559732$   
 with  $p_t = 0.00380895$   
 $p_c = 0.00380895$   
 $p_v = 0.00232477$   
 $N = 3615.026$   
 $b = 670.00$   
 $" = 0.12044818$   
 $y_{comp} = 2.7622786E-005$   
 with  $f_c = 33.00$   
 $E_c = 26999.444$   
 $y = 0.22309812$   
 $A = 0.00990831$   
 $B = 0.00557012$   
 with  $E_s = 200000.00$

Calculation of ratio  $l_b/l_d$

Adequate Lap Length:  $l_b/l_d \geq 1$

- Calculation of  $p$  -

From table 10-7:  $p = 0.03$   
 with:

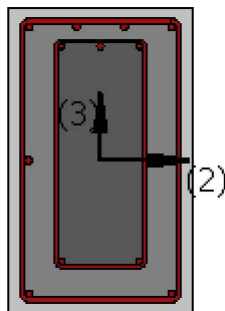
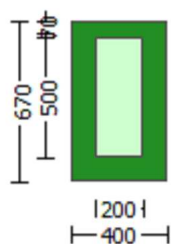
- Condition i occurred  
Beam controlled by flexure:  $V_p/V_o \leq 1$   
shear control ratio  $V_p/V_o = 0.53480887$
- Transverse Reinforcement: NC
- Stirrup Spacing  $> d/3$
- Low ductility demand,  $\lambda / y < 2$  (table 10-6, ASCE 41-17)  
 $= -8.9954028E-023$
- Stirrup Spacing  $\leq d/2$   
 $d = d_{\text{external}} = 357.00$   
 $s = s_{\text{external}} = 150.00$
- Strength provided by hoops  $V_s < 3/4 \cdot \text{design Shear}$   
 $V_s = 215957.134$ , already given in calculation of shear control ratio  
design Shear =  $1.6099959E-014$
- $(\lambda - \lambda') / \lambda = -0.23508921$   
 $\lambda = A_{st}/(b_w \cdot d) = 0.00296835$   
Tension Reinf Area:  $A_{st} = 709.9999$   
 $\lambda' = A_{sc}/(b_w \cdot d) = 0.00697431$   
Compression Reinf Area:  $A_{sc} = 1668.186$   
From (B-1), ACI 318-11:  $\lambda = 0.01704017$   
 $f_c = (f_{c\_jacket} \cdot \text{Area}_{jacket} + f_{c\_core} \cdot \text{Area}_{core}) / \text{section\_area} = 33.00$   
 $f_y = f_{y\_jacket\_bars} = 555.56$   
From 10.2.7.3, ACI 318-11:  $\lambda = 0.65$   
From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + \lambda) = 0.51922877$   
 $\lambda = 0.0027778$
- $V / (b_w \cdot d \cdot f_c^{0.5}) = 1.4110682E-019$ , 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)

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## 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,  $\gamma = 0.85$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Secondary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Secondary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Secondary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Secondary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ( $l_o/l_{o,min} = l_b/l_d \geq 1$ )

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment,  $M_a = -2.3875458E-011$

Shear Force,  $V_a = -1.6099959E-014$

EDGE -B-

Bending Moment,  $M_b = -2.4334440E-011$

Shear Force,  $V_b = 1.6099959E-014$

BOTH EDGES

Axial Force,  $F = -3615.026$

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:  $Asl_{mid} = 556.0619$   
Mean Diameter of Tension Reinforcement,  $DbL_{ten} = 15.20$

New component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $VR = 1.0 \cdot V_n = 339071.608$   
 $V_n ((22.5.1.1), ACI 318-14) = 339071.608$

NOTE: In expression (22.5.1.1) ' $V_w$ ' is replaced by ' $V_w + f \cdot V_f$ '  
where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 171520.00$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 25.00$ , but  $fc'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = As / (b_w \cdot d) = 0.00331157$   
 $As$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 2.4334440E-011$   
 $V_u = 1.6099959E-014$   
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)

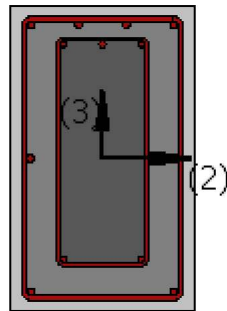
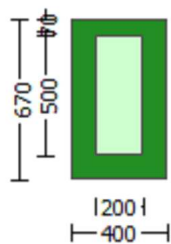
Analysis: Uniform +X

Check: Chord rotation capacity ( $\phi_r$ )

Edge: End

Local Axis: (2)





Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 0.85$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Secondary 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 Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$

Existing Column

New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length,  $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ( $l_o/l_{ou, \min} \geq 1$ )

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force,  $V_a = 9840.632$

EDGE -B-

Shear Force,  $V_b = 9840.634$

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:  $As_{mid} = 402.1239$

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 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 static loading combination  
 and  
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$   
 with  
 $V_1 = 9840.632$ , is the shear force acting at edge 1 for the static loading combination  
 $V_2 = 9840.634$ , 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:  
 $\phi_u = 5.6088283E-005$   
 $M_u = 4.3734E+008$

with full section properties:

$b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $\phi_c (5A.5, \text{TB DY}) = 0.002$   
 Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00514506$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TB DY:  $\phi_u = 0.00514506$   
 $w_e (5.4c) = 0.00169139$   
 $a_{se} ((5.4d), \text{TB DY}) = (a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int})/A_{sec} = 0.14776895$   
 $a_{se1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $p_{sh,min} \cdot F_{ywe} = \text{Min}(p_{sh,x} \cdot F_{ywe}, p_{sh,y} \cdot F_{ywe}) = 1.25908$   
 Expression ((5.4d), TB DY) for  $p_{sh,min} \cdot F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{sh2} \cdot F_{ywe2} = 2.25223$

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00261799$$

$$Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$$

$$\text{No stirups, } ns\_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00062519$$

$$Ash2 = Astir\_2 \cdot ns\_2 = 100.531$$

$$\text{No stirups, } ns\_2 = 2.00$$

$$h2 = 500.00$$

$$psh\_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.25908$$

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$$

$$Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$$

$$\text{No stirups, } ns\_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$$

$$Ash2 = Astir\_2 \cdot ns\_2 = 100.531$$

$$\text{No stirups, } ns\_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 694.45$$

$$fce = 33.00$$

$$\text{From } ((5A5), \text{ TBDY}), \text{ TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 833.34$$

$$fy1 = 694.45$$

$$su1 = 0.032$$

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

$$lo/lou, \min = lb/l_d = 1.00$$

$$su1 = 0.4 \cdot esu1\_nominal \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu1\_nominal = 0.08,$$

For calculation of esu1\_nominal and y1, sh1, ft1, fy1, it is considered  
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs1 = (fs\_jacket \cdot Asl, \text{ten, jacket} + fs\_core \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 694.45$$

$$\text{with } Es1 = (Es\_jacket \cdot Asl, \text{ten, jacket} + Es\_core \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 833.34$$

$$fy2 = 694.45$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou, \min = lb/l_b, \min = 1.00$$

$$su2 = 0.4 \cdot esu2\_nominal \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu2\_nominal = 0.08,$$

For calculation of esu2\_nominal and y2, sh2, ft2, fy2, it is considered  
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs2 = (fs\_jacket \cdot Asl, \text{com, jacket} + fs\_core \cdot Asl, \text{com, core}) / Asl, \text{com} = 694.45$$

$$\text{with } Es2 = (Es\_jacket \cdot Asl, \text{com, jacket} + Es\_core \cdot Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 833.34$$

$$fyv = 694.45$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $suv = 0.4 * esuv\_nominal ((5.5), TBDY) = 0.032$   
 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  $fsv = (fs\_jacket * Asl\_mid\_jacket + fs\_mid * Asl\_mid\_core) / Asl\_mid = 694.45$   
 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:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl\_ten / (b * d) * (fs1 / fc) = 0.0736092$   
 $2 = Asl\_com / (b * d) * (fs2 / fc) = 0.13125889$   
 $v = Asl\_mid / (b * d) * (fsv / fc) = 0.04169017$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < vsy2$  - 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  $Mu1$ -

Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:

$u = 5.9367084E-005$   
 $Mu = 7.4472E+008$

with full section properties:

$b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$   
 $fc = 33.00$   
 $co (5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00514506$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00514506$   
 $we (5.4c) = 0.00169139$   
 $ase ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo\_1 = 340.00$   
 $ho\_1 = 610.00$   
 $bi2\_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$

$psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.25908$   
 Expression ((5.4d), TBDY) for  $psh,min*Fywe$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.25223$   
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00261799$   
 $Ash1 = Astir\_1*ns\_1 = 157.0796$   
 No stirrups,  $ns\_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00062519$   
 $Ash2 = Astir\_2*ns\_2 = 100.531$   
 No stirrups,  $ns\_2 = 2.00$   
 $h2 = 500.00$

$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.25908$   
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00156298$   
 $Ash1 = Astir\_1*ns\_1 = 157.0796$   
 No stirrups,  $ns\_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00025008$   
 $Ash2 = Astir\_2*ns\_2 = 100.531$   
 No stirrups,  $ns\_2 = 2.00$   
 $h2 = 200.00$

$Asec = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fywe1 = 694.45$   
 $fywe2 = 694.45$   
 $fce = 33.00$

From ((5.A5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$

$y1 = 0.0025$   
 $sh1 = 0.008$   
 $ft1 = 833.34$   
 $fy1 = 694.45$   
 $su1 = 0.032$

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) = 0.10623177
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) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
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
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00514506
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00514506
we (5.4c) = 0.00169139
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895

```

$bo\_1 = 340.00$   
 $ho\_1 = 610.00$   
 $bi2\_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$   
 $psh, min*Fywe = \text{Min}(psh, x*Fywe, psh, y*Fywe) = 1.25908$   
 Expression ((5.4d), TBDY) for  $psh, min*Fywe$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh\_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.25223$   
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00261799$   
 $Ash1 = Astir\_1*ns\_1 = 157.0796$   
 No stirrups,  $ns\_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00062519$   
 $Ash2 = Astir\_2*ns\_2 = 100.531$   
 No stirrups,  $ns\_2 = 2.00$   
 $h2 = 500.00$

$psh\_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.25908$   
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00156298$   
 $Ash1 = Astir\_1*ns\_1 = 157.0796$   
 No stirrups,  $ns\_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00025008$   
 $Ash2 = Astir\_2*ns\_2 = 100.531$   
 No stirrups,  $ns\_2 = 2.00$   
 $h2 = 200.00$

$Asec = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fywe1 = 694.45$   
 $fywe2 = 694.45$   
 $fce = 33.00$

From ((5.A5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$

$y1 = 0.0025$   
 $sh1 = 0.008$   
 $ft1 = 833.34$   
 $fy1 = 694.45$   
 $su1 = 0.032$

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  $f_{sy2} = f_{s2}/1.2$ , 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  $f_{s2} = (f_{sjacket} \cdot A_{sl,mid,jacket} + f_{s,core} \cdot A_{sl,mid,core}) / A_{sl,com} = 694.45$   
 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  $E_{sv} = (E_{sjacket} \cdot A_{sl,mid,jacket} + E_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 200000.00$   
 $1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.05957415$   
 $2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.10623177$   
 $v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.03374111$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.0736092$   
 $2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.13125889$   
 $v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.04169017$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.09006517$   
 $Mu = MR_c (4.14) = 4.3734E+008$   
 $u = su (4.1) = 5.6088283E-005$

Calculation of ratio  $l_b/l_d$

Adequate Lap Length:  $l_b/l_d \geq 1$

Calculation of  $Mu_2$ -

Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:

$u = 5.9367084E-005$   
 $Mu = 7.4472E+008$

with full section properties:

$b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $co (5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = \text{shear\_factor} \cdot \text{Max}(cu, cc) = 0.00514506$



The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $c_u = 0.00514506$   
 $w_e$  (5.4c) = 0.00169139  
 $a_{se}$  ((5.4d), TBDY) =  $(a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int}) / A_{sec} = 0.14776895$   
 $a_{se1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $p_{sh, \min} \cdot F_{ywe} = \text{Min}(p_{sh, x} \cdot F_{ywe}, p_{sh, y} \cdot F_{ywe}) = 1.25908$   
 Expression ((5.4d), TBDY) for  $p_{sh, \min} \cdot F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh, x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 2.25223$   
 $p_{s1}$  (external) =  $(A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} \cdot n_{s\_1} = 157.0796$   
 No stirrups,  $n_{s\_1} = 2.00$   
 $h_1 = 670.00$   
 $p_{s2}$  (internal) =  $(A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00062519$   
 $A_{sh2} = A_{stir\_2} \cdot n_{s\_2} = 100.531$   
 No stirrups,  $n_{s\_2} = 2.00$   
 $h_2 = 500.00$

$p_{sh, y} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 1.25908$   
 $p_{s1}$  (external) =  $(A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00156298$   
 $A_{sh1} = A_{stir\_1} \cdot n_{s\_1} = 157.0796$   
 No stirrups,  $n_{s\_1} = 2.00$   
 $h_1 = 400.00$   
 $p_{s2}$  (internal) =  $(A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00025008$   
 $A_{sh2} = A_{stir\_2} \cdot n_{s\_2} = 100.531$   
 No stirrups,  $n_{s\_2} = 2.00$   
 $h_2 = 200.00$

$A_{sec} = 268000.00$   
 $s_1 = 150.00$   
 $s_2 = 300.00$   
 $f_{ywe1} = 694.45$   
 $f_{ywe2} = 694.45$   
 $f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY:  $c_c = 0.002$   
 $c$  = confinement factor = 1.00

$y_1 = 0.0025$   
 $sh_1 = 0.008$   
 $ft_1 = 833.34$   
 $fy_1 = 694.45$   
 $su_1 = 0.032$

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

$l_o / l_{ou, \min} = l_b / l_d = 1.00$

$su_1 = 0.4 \cdot e_{su1\_nominal}$  ((5.5), TBDY) = 0.032

From table 5A.1, TBDY:  $e_{su1\_nominal} = 0.08$ ,

For calculation of  $e_{su1\_nominal}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered  
 characteristic value  $fsy_1 = fs_1 / 1.2$ , 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  
 $l_o/l_{ou,min} = l_b/l_{b,min} = 1.00$   
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$   
 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  $Es_v = (Es_{jacket} * Asl_{mid,jacket} + Es_{mid} * Asl_{mid,core}) / Asl_{mid} = 200000.00$   
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.10623177$   
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.05957415$   
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.03374111$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.13125889$   
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.0736092$   
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.04169017$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < v_{s,y_2}$  - 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  $l_b/l_d$

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) 'Vw' is replaced by 'Vw+ f\*Vf'  
 where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 209131.476$

= 1 (normal-weight concrete)  
Mean concrete strength:  $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 33.00$ , 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  
 $bw = 400.00$   
 $d = 536.00$   
 $Vu \cdot d / Mu < 1 = 1.00$   
 $Mu = 1.0197E+006$   
 $Vu = 9840.632$   
From (11.5.4.8), ACI 318-14:  $Vs1 + Vs2 = 349068.643$   
 $Vs1 = 311834.654$  is calculated for jacket, with:  
 $d = 536.00$   
 $Av = 157079.633$   
 $fy = 555.56$   
 $s = 150.00$   
 $Vs1$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $Vs2 = 37233.989$  is calculated for jacket, with:  
 $d2 = 400.00$   
 $Av = 100530.965$   
 $fy = 555.56$   
 $s = 300.00$   
 $Vs2$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)  
 $2(1-s/d) = 0.50$   
 $Vf$  ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440:  $Vs + Vf \leq 818179.336$

-----  
Calculation of Shear Strength at edge 2,  $Vr2 = 558200.119$   
 $Vr2 = Vn$  ((22.5.1.1), ACI 318-14)

-----  
NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f\*Vf'  
where Vf is the contribution of FRPs (11.3), ACI 440).

-----  
From Table (22.5.5.1), ACI 318-14:  $Vc = 209131.476$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 33.00$ , 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  
 $bw = 400.00$   
 $d = 536.00$   
 $Vu \cdot d / Mu < 1 = 1.00$   
 $Mu = 1.0197E+006$   
 $Vu = 9840.634$   
From (11.5.4.8), ACI 318-14:  $Vs1 + Vs2 = 349068.643$   
 $Vs1 = 311834.654$  is calculated for jacket, with:  
 $d = 536.00$   
 $Av = 157079.633$   
 $fy = 555.56$   
 $s = 150.00$   
 $Vs1$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $Vs2 = 37233.989$  is calculated for jacket, with:  
 $d = 400.00$   
 $Av = 100530.965$   
 $fy = 555.56$   
 $s = 300.00$   
 $Vs2$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)  
 $2(1-s/d) = 0.50$   
 $Vf$  ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440:  $Vs + Vf \leq 818179.336$

-----  
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,   = 0.85
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$ 
New material of Secondary Member: Steel Strength,  $f_s = f_{sm} = 555.56$ 
Concrete Elasticity,  $E_c = 26999.444$ 
Steel Elasticity,  $E_s = 200000.00$ 
Existing Column
New material of Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$ 
New material of Secondary Member: Steel Strength,  $f_s = f_{sm} = 555.56$ 
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 = 1.00
Element Length,  $L = 3000.00$ 
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ( $l_o/l_{ou,min} \geq 1$ )
No FRP Wrapping
-----

Stepwise Properties
-----
At local axis: 2
EDGE -A-
Shear Force,  $V_a = 1.8202823E-014$ 
EDGE -B-
Shear Force,  $V_b = -1.8202823E-014$ 
BOTH EDGES
Axial Force,  $F = -2237.255$ 
Longitudinal Reinforcement Area Distribution (in 2 divisions)
  -Tension:  $As_t = 709.9999$ 
  -Compression:  $As_c = 1668.186$ 
Longitudinal Reinforcement Area Distribution (in 3 divisions)
  -Tension:  $As_{t,ten} = 911.0619$ 
  -Compression:  $As_{l,com} = 911.0619$ 
  -Middle:  $As_{l,mid} = 556.0619$ 
-----
-----

Calculation of Shear Capacity ratio ,  $V_e/V_r = 0.53480887$ 
Member Controlled by Flexure ( $V_e/V_r < 1$ )
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u*l_n/2 = 204955.561$ 

```

with  
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 3.0743\text{E}+008$   
 $\mu_{u1+} = 3.0743\text{E}+008$ , is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination  
 $\mu_{u1-} = 3.0743\text{E}+008$ , is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination  
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 3.0743\text{E}+008$   
 $\mu_{u2+} = 3.0743\text{E}+008$ , is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination  
 $\mu_{u2-} = 3.0743\text{E}+008$ , is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination  
and  
 $\pm v_w \cdot l_n = (|V1| + |V2|)/2$   
with  
 $V1 = 1.8202823\text{E}-014$ , is the shear force acting at edge 1 for the static loading combination  
 $V2 = -1.8202823\text{E}-014$ , 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:

$u = 0.00010406$   
 $\mu_u = 3.0743\text{E}+008$   
-----

with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $\alpha (5A.5, \text{TBDY}) = 0.002$

Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} \cdot \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00514506$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $\phi_{cu} = 0.00514506$

$\phi_{we} (5.4c) = 0.00169139$

$a_{se} ((5.4d), \text{TBDY}) = (a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int}) / A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o\_1} = 340.00$

$h_{o\_1} = 610.00$

$b_{i2\_1} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o\_2} = 192.00$

$h_{o\_2} = 492.00$

$b_{i2\_2} = 557856.00$

$\phi_{sh,min} \cdot F_{ywe} = \text{Min}(\phi_{sh,x} \cdot F_{ywe}, \phi_{sh,y} \cdot F_{ywe}) = 1.25908$

Expression ((5.4d), TBDY) for  $\phi_{sh,min} \cdot F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

-----  
 $\phi_{sh,x} \cdot F_{ywe} = \phi_{sh1} \cdot F_{ywe1} + \phi_{sh2} \cdot F_{ywe2} = 2.25223$

$\phi_{sh1} \text{ (external)} = (A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir\_1} \cdot n_{s\_1} = 157.0796$

No stirrups,  $n_{s\_1} = 2.00$

$h_1 = 670.00$

$\phi_{sh2} \text{ (internal)} = (A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00062519$

$A_{sh2} = A_{stir\_2} \cdot n_{s\_2} = 100.531$

No stirrups,  $n_{s\_2} = 2.00$

$h_2 = 500.00$   
-----

$\phi_{sh,y} \cdot F_{ywe} = \phi_{sh1} \cdot F_{ywe1} + \phi_{sh2} \cdot F_{ywe2} = 1.25908$

$\phi_{sh1} \text{ (external)} = (A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00156298$

$A_{sh1} = A_{stir\_1} \cdot n_{s\_1} = 157.0796$

No stirrups,  $n_{s\_1} = 2.00$

$h_1 = 400.00$

$\phi_{sh2} \text{ (internal)} = (A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00025008$

Ash2 = Astir\_2\*ns\_2 = 100.531  
 No stirups, ns\_2 = 2.00  
 h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

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  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket\*Asl,ten,jacket + fs,core\*Asl,ten,core)/Asl,ten = 694.45

with Es1 = (Es,jacket\*Asl,ten,jacket + Es,core\*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025

sh2 = 0.008

ft2 = 833.34

fy2 = 694.45

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4\*esu2\_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2\_nominal = 0.08,

For calculation of esu2\_nominal and y2, sh2,ft2,fy2, it is considered  
 characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket\*Asl,com,jacket + fs,core\*Asl,com,core)/Asl,com = 694.45

with Es2 = (Es,jacket\*Asl,com,jacket + Es,core\*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 833.34

fyv = 694.45

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00

lo/lou,min = lb/ld = 1.00

suv = 0.4\*esuv\_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv\_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY  
 For calculation of esuv\_nominal and yv, shv,ftv,fyv, it is considered  
 characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket\*Asl,mid,jacket + fs,mid\*Asl,mid,core)/Asl,mid = 694.45

with Esv = (Es,jacket\*Asl,mid,jacket + Es,mid\*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.08015524

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) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
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) = 0.00514506
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00514506
we (5.4c) = 0.00169139
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.25908
Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

```

```

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25223
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 500.00

```

```

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25908

```

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$$

$$Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$$

$$\text{No stirups, } ns\_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$$

$$Ash2 = Astir\_2 \cdot ns\_2 = 100.531$$

$$\text{No stirups, } ns\_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 694.45$$

$$fce = 33.00$$

$$\text{From } ((5A5), \text{ TBDY}), \text{ TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 833.34$$

$$fy1 = 694.45$$

$$su1 = 0.032$$

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

$$lo/lou, \min = lb/ld = 1.00$$

$$su1 = 0.4 \cdot esu1\_nominal \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu1\_nominal = 0.08,$$

For calculation of esu1\_nominal and y1, sh1, ft1, fy1, it is considered  
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs1 = (fs\_jacket \cdot Asl, \text{ten}, \text{jacket} + fs\_core \cdot Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 694.45$$

$$\text{with } Es1 = (Es\_jacket \cdot Asl, \text{ten}, \text{jacket} + Es\_core \cdot Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 833.34$$

$$fy2 = 694.45$$

$$su2 = 0.032$$

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

$$lo/lou, \min = lb/lb, \min = 1.00$$

$$su2 = 0.4 \cdot esu2\_nominal \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu2\_nominal = 0.08,$$

For calculation of esu2\_nominal and y2, sh2, ft2, fy2, it is considered  
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs2 = (fs\_jacket \cdot Asl, \text{com}, \text{jacket} + fs\_core \cdot Asl, \text{com}, \text{core}) / Asl, \text{com} = 694.45$$

$$\text{with } Es2 = (Es\_jacket \cdot Asl, \text{com}, \text{jacket} + Es\_core \cdot Asl, \text{com}, \text{core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 833.34$$

$$fyv = 694.45$$

$$suv = 0.032$$

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

$$lo/lou, \min = lb/ld = 1.00$$

$$suv = 0.4 \cdot esuv\_nominal \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esuv\_nominal = 0.08,$$

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv\_nominal and yv, shv, ftv, fyv, it is considered  
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fsv = (fs\_jacket \cdot Asl, \text{mid}, \text{jacket} + fs\_mid \cdot Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 694.45$$

$$\text{with } Esv = (Es\_jacket \cdot Asl, \text{mid}, \text{jacket} + Es\_mid \cdot Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 200000.00$$

$$1 = Asl, \text{ten} / (b \cdot d) \cdot (fs1 / fce) = 0.08015524$$



$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.08015524$   
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.04892233$   
 and confined core properties:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.09611636$   
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.09611636$   
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05866412$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' does not satisfy Eq. (4.3)

--->  
 $v < v_{s,c}$  - RHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.13857861$   
 $Mu = MR_c (4.14) = 3.0743E+008$   
 $u = su (4.1) = 0.00010406$

Calculation of ratio  $l_b/l_d$

Adequate Lap Length:  $l_b/l_d \geq 1$

Calculation of  $Mu_{2+}$

Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:  
 $u = 0.00010406$   
 $Mu = 3.0743E+008$

with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, cc) = 0.00514506$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $\phi_u = 0.00514506$   
 $\phi_{we} (5.4c) = 0.00169139$   
 $\phi_{ase} ((5.4d), TBDY) = (\phi_{ase1} * A_{ext} + \phi_{ase2} * A_{int}) / A_{sec} = 0.14776895$   
 $\phi_{ase1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $\phi_{ase2} = \text{Max}(\phi_{ase1}, \phi_{ase2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $\phi_{psh,min} * F_{ywe} = \text{Min}(\phi_{psh,x} * F_{ywe}, \phi_{psh,y} * F_{ywe}) = 1.25908$   
 Expression ((5.4d), TBDY) for  $\phi_{psh,min} * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$\phi_{psh,x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 2.25223$   
 $\phi_{ps1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 No stirrups,  $n_{s\_1} = 2.00$   
 $h_1 = 670.00$   
 $\phi_{ps2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$

Ash2 = Astir\_2\*ns\_2 = 100.531  
 No stirups, ns\_2 = 2.00  
 h2 = 500.00

psh\_y\*Fywe = psh1\*Fywe1+ps2\*Fywe2 = 1.25908  
 ps1 (external) = (Ash1\*h1/s1)/Asec = 0.00156298  
 Ash1 = Astir\_1\*ns\_1 = 157.0796  
 No stirups, ns\_1 = 2.00  
 h1 = 400.00  
 ps2 (internal) = (Ash2\*h2/s2)/Asec = 0.00025008  
 Ash2 = Astir\_2\*ns\_2 = 100.531  
 No stirups, ns\_2 = 2.00  
 h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.0025

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:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

$f_{cc} \text{ (5A.2, TBDY)} = 33.00$

$cc \text{ (5A.5, TBDY)} = 0.002$

$c = \text{confinement factor} = 1.00$

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.09611636$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.09611636$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.05866412$

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  $Mu_2$ -

-----

Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:

$u = 0.00010406$

$Mu = 3.0743E+008$

-----

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$f_c = 33.00$

$co \text{ (5A.5, TBDY)} = 0.002$

Final value of  $cu$ :  $cu^* = \text{shear\_factor} \cdot \text{Max}(cu, cc) = 0.00514506$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $cu = 0.00514506$

we (5.4c) =  $0.00169139$

ase ((5.4d), TBDY) =  $(ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$

ase1 =  $0.14776895$

bo\_1 =  $340.00$

ho\_1 =  $610.00$

bi2\_1 =  $975400.00$

ase2 =  $\text{Max}(ase1, ase2) = 0.14776895$

bo\_2 =  $192.00$

ho\_2 =  $492.00$

bi2\_2 =  $557856.00$

$psh_{min} \cdot F_{ywe} = \text{Min}(psh_x \cdot F_{ywe}, psh_y \cdot F_{ywe}) = 1.25908$

Expression ((5.4d), TBDY) for  $psh_{min} \cdot F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

-----

$psh_x \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 2.25223$

$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00261799$   
 $Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$   
 No stirups,  $ns\_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00062519$   
 $Ash2 = Astir\_2 \cdot ns\_2 = 100.531$   
 No stirups,  $ns\_2 = 2.00$   
 $h2 = 500.00$

$psh\_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.25908$   
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$   
 $Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$   
 No stirups,  $ns\_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$   
 $Ash2 = Astir\_2 \cdot ns\_2 = 100.531$   
 No stirups,  $ns\_2 = 2.00$   
 $h2 = 200.00$

$Asec = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fywe1 = 694.45$   
 $fywe2 = 694.45$   
 $fce = 33.00$

From ((5.A5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$

$y1 = 0.0025$   
 $sh1 = 0.008$   
 $ft1 = 833.34$   
 $fy1 = 694.45$   
 $su1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $Shear\_factor = 1.00$   
 $lo/lou, min = lb/l_d = 1.00$

$su1 = 0.4 \cdot esu1\_nominal \text{ ((5.5), TBDY)} = 0.032$

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  $\text{Min}(1, 1.25 \cdot (lb/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs1 = (fs\_jacket \cdot Asl, ten, jacket + fs\_core \cdot Asl, ten, core) / Asl, ten = 694.45$

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  
 $Shear\_factor = 1.00$

$lo/lou, min = lb/l_b, min = 1.00$

$su2 = 0.4 \cdot esu2\_nominal \text{ ((5.5), TBDY)} = 0.032$

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  $\text{Min}(1, 1.25 \cdot (lb/l_d)^{2/3})$ , 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  
 $Shear\_factor = 1.00$

$l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $s_{uv} = 0.4 \cdot e_{suv\_nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $e_{suv\_nominal} = 0.08$ ,  
 considering characteristic value  $f_{syv} = f_{sv}/1.2$ , from table 5.1, TBDY  
 For calculation of  $e_{suv\_nominal}$  and  $y_v$ ,  $sh_v, ft_v, f_{yv}$ , it is considered  
 characteristic value  $f_{syv} = f_{sv}/1.2$ , from table 5.1, TBDY.  
 $y_1$ ,  $sh_1, ft_1, f_{y1}$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $f_{sv} = (f_{sj\_jacket} \cdot A_{sl,mid,jacket} + f_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 694.45$   
 with  $E_{sv} = (E_{sj\_jacket} \cdot A_{sl,mid,jacket} + E_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 200000.00$   
 $1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.08015524$   
 $2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.08015524$   
 $v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.04892233$

and confined core properties:

$b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.09611636$   
 $2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.09611636$   
 $v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.05866412$

Case/Assumption: Unconfined full section - Steel rupture  
 ' does not satisfy Eq. (4.3)

--->

$v < v_{s,c}$  - RHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.13857861$   
 $Mu = MRc (4.14) = 3.0743E+008$   
 $u = su (4.1) = 0.00010406$

Calculation of ratio  $l_b/l_d$

Adequate Lap Length:  $l_b/l_d \geq 1$

Calculation of Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 383231.42$

Calculation of Shear Strength at edge 1,  $V_{r1} = 383231.42$   
 $V_{r1} = V_n ((22.5.1.1), ACI 318-14)$

NOTE: In expression (22.5.1.1) ' $V_w$ ' is replaced by ' $V_w + f \cdot V_f$ '  
 where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 197061.477$   
 $= 1$  (normal-weight concrete)  
 Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot \text{Area}_{jacket} + f'_{c\_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$ , but  $f'_c^{0.5} \leq 8.3$   
 MPa (22.5.3.1, ACI 318-14)  
 $p_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / Mu < 1 = 0.00$   
 $Mu = 4.0861879E-011$   
 $V_u = 1.8202823E-014$   
 From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$   
 $V_{s1} = 186169.943$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17, 10.3.4)  
 $V_{s2} = 0.00$  is calculated for jacket, with:  
 $d_2 = 160.00$

$$A_v = 100530.965$$

$$f_y = 555.56$$

$$s = 300.00$$

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).

$$\text{From Table } (22.5.5.1), \text{ACI 318-14: } V_c = 197061.477$$

$$= 1 \text{ (normal-weight concrete)}$$

$$\text{Mean concrete strength: } f'_c = (f'_c_{\text{jacket}} * \text{Area}_{\text{jacket}} + f'_c_{\text{core}} * \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 33.00, \text{ but } f'_c^{0.5} \leq 8.3 \text{ MPa } (22.5.3.1, \text{ACI 318-14})$$

$$p_w = A_s / (b_w * d) = 0.00331157$$

$$A_s \text{ (tension reinf.)} = 709.9999$$

$$b_w = 670.00$$

$$d = 320.00$$

$$V_u * d / M_u < 1 = 0.00$$

$$M_u = 1.3749363E-011$$

$$V_u = 1.8202823E-014$$

$$\text{From } (11.5.4.8), \text{ACI 318-14: } V_{s1} + V_{s2} = 186169.943$$

$V_{s1} = 186169.943$  is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

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

$$\text{Knowledge Factor, } \phi = 0.85$$

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

$$\text{New material of Secondary Member: Concrete Strength, } f_c = f_{cm} = 33.00$$

$$\text{New material of Secondary Member: Steel Strength, } f_s = f_{sm} = 555.56$$

$$\text{Concrete Elasticity, } E_c = 26999.444$$

$$\text{Steel Elasticity, } E_s = 200000.00$$

Existing Column

$$\text{New material of Secondary Member: Concrete Strength, } f_c = f_{cm} = 33.00$$

$$\text{New material of Secondary Member: Steel Strength, } f_s = f_{sm} = 555.56$$

$$\text{Concrete Elasticity, } E_c = 26999.444$$

$$\text{Steel Elasticity, } E_s = 200000.00$$

External Height, H = 670.00  
 External Width, W = 400.00  
 Internal Height, H = 500.00  
 Internal Width, W = 200.00  
 Cover Thickness, c = 25.00  
 Element Length, L = 3000.00  
 Secondary Member  
 Ribbed Bars  
 Ductile Steel  
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)  
 Longitudinal Bars With Ends Lapped Starting at the End Sections  
 Adequate Lap Length ( $l_b/d \geq 1$ )  
 No FRP Wrapping

#### Stepwise Properties

Bending Moment, M = 1.0660E+007  
 Shear Force, V2 = 1.6099959E-014  
 Shear Force, V3 = 15660.98  
 Axial Force, F = -3615.026  
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
   -Tension: Asl,t = 709.9999  
   -Compression: Asl,c = 1668.186  
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
   -Tension: Asl,ten = 709.9999  
   -Compression: Asl,com = 1266.062  
   -Middle: Asl,mid = 402.1239  
 Longitudinal External Reinforcement Area Distribution (in 3 divisions)  
   -Tension: Asl,ten,jacket = 402.1239  
   -Compression: Asl,com,jacket = 804.2477  
   -Middle: Asl,mid,jacket = 402.1239  
 Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)  
   -Tension: Asl,ten,core = 307.8761  
   -Compression: Asl,com,core = 461.8141  
   -Middle: Asl,mid,core = 0.00  
 Mean Diameter of Tension Reinforcement, DbL = 15.00

New component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u_R = 1.0^*$   $u = 0.0507643$   
 $u = y + p = 0.0507643$

- Calculation of  $y$  -

$y = (M_y * L_s / 3) / E_{eff} = 0.0007643$  ((4.29), Biskinis Phd))  
 $M_y = 2.7353E+008$   
 $L_s = M/V$  (with  $L_s > 0.1 * L$  and  $L_s < 2 * L$ ) = 680.6999  
 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 -

$y = \text{Min}(y_{ten}, y_{com})$   
 $y_{ten} = 5.4341293E-006$   
 with  $f_y = 555.56$   
 $d = 627.00$   
 $y = 0.18472625$   
 $A = 0.00950834$   
 $B = 0.00405975$   
 with  $p_t = 0.00283094$   
 $p_c = 0.00504809$

$p_v = 0.00160336$   
 $N = 3615.026$   
 $b = 400.00$   
 $" = 0.06858054$   
 $y_{comp} = 1.9040135E-005$   
 with  $f_c = 33.00$   
 $E_c = 26999.444$   
 $y = 0.18428672$   
 $A = 0.00944964$   
 $B = 0.0040338$   
 with  $E_s = 200000.00$

Calculation of ratio  $I_b/I_d$

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)  
 $= -1.1965175E-006$
- 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 = 15660.98
- $(\rho_t - \rho'_t)/\rho_{bal} = -0.22420649$   
 $= A_{st}/(b_w \cdot d) = 0.00283094$   
 Tension Reinf Area:  $A_{st} = 709.9999$   
 $\rho'_t = A_{sc}/(b_w \cdot d) = 0.00665146$   
 Compression Reinf Area:  $A_{sc} = 1668.186$
- From (B-1), ACI 318-11:  $\rho_{bal} = 0.01704017$   
 $f_c = (f_{c\_jacket} \cdot \text{Area}_{jacket} + f_{c\_core} \cdot \text{Area}_{core}) / \text{section\_area} = 33.00$   
 $f_y = f_{y\_jacket\_bars} = 555.56$   
 From 10.2.7.3, ACI 318-11:  $\beta_1 = 0.65$   
 From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + \gamma) = 0.51922877$   
 $\gamma = 0.0027778$
- $V/(b_w \cdot d \cdot f_c^{0.5}) = 0.13090543$ , NOTE: units in  $I_b$  & in  
 $b_w = 400.00$

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

**Calculation No. 15**



beam B1, Floor 1

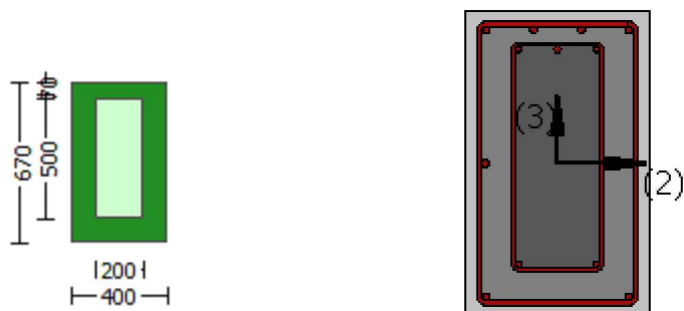
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity  $V_{Rd}$

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 0.85$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Secondary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Secondary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Secondary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Secondary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ( $l_o/l_{ou,min} = l_b/l_d \geq 1$ )

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment,  $M_a = 6.8008\text{E}+006$

Shear Force,  $V_a = 4020.286$

EDGE -B-

Bending Moment,  $M_b = 1.0660\text{E}+007$

Shear Force,  $V_b = 15660.98$

BOTH EDGES

Axial Force,  $F = -3615.026$

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  $V_R = 1.0 \cdot V_n = 495183.482$

$V_n$  ((22.5.1.1), ACI 318-14) = 495183.482

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:  $V_c = 181024.216$

= 1 (normal-weight concrete)

Mean concrete strength:  $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 25.00$ , but  $f'_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$\rho_w = A_s / (b_w \cdot d) = 0.00331157$

$A_s$  (tension reinf.) = 709.9999

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / M_u < 1 = 0.78742478$

$M_u = 1.0660\text{E}+007$

$V_u = 15660.98$

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

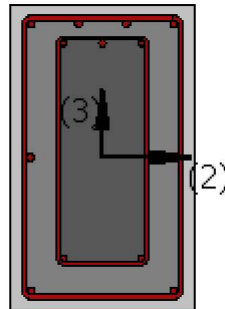
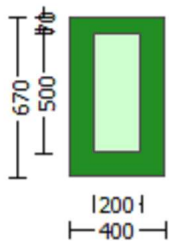
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

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,  $\phi = 0.85$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$

Existing Column

New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$   
Mean Confinement Factor overall section = 1.00  
Element Length,  $L = 3000.00$   
Secondary Member  
Ribbed Bars  
Ductile Steel  
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)  
Longitudinal Bars With Ends Lapped Starting at the End Sections  
Adequate Lap Length ( $l_o/l_{ou}, \min \geq 1$ )  
No FRP Wrapping

#### Stepwise Properties

At local axis: 3  
EDGE -A-  
Shear Force,  $V_a = 9840.632$   
EDGE -B-  
Shear Force,  $V_b = 9840.634$   
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  
 $V_1 = 9840.632$ , is the shear force acting at edge 1 for the static loading combination  
 $V_2 = 9840.634$ , 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  $c_u$ :  $c_u^* = \text{shear\_factor} * \text{Max}(c_u, c_o) = 0.00514506$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $c_u = 0.00514506$   
 $w_e (5.4c) = 0.00169139$   
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$   
 $a_{se1} = 0.14776895$   
 $b_o_1 = 340.00$   
 $h_o_1 = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$   
 $b_o_2 = 192.00$   
 $h_o_2 = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$   
 Expression ((5.4d), TBDY) for  $p_{sh, \min} * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.25223$   
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 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.A5), TBDY), TBDY:  $c_c = 0.002$   
 $c = \text{confinement factor} = 1.00$

$y_1 = 0.0025$   
 $sh_1 = 0.008$   
 $ft_1 = 833.34$   
 $fy_1 = 694.45$   
 $su_1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$

$l_o / l_{ou, \min} = l_b / l_d = 1.00$

$su_1 = 0.4 * esu_{1\_nominal} ((5.5), TBDY) = 0.032$

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  $fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 694.45$

with  $Es_1 = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$

$y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$   
 $fy_2 = 694.45$

```

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) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0736092
2 = Asl,com/(b*d)*(fs2/fc) = 0.13125889
v = Asl,mid/(b*d)*(fsv/fc) = 0.04169017
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.09006517
Mu = MRc (4.14) = 4.3734E+008
u = su (4.1) = 5.6088283E-005

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 5.9367084E-005

Mu = 7.4472E+008

with full section properties:

$b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027032$   
 $N = 2237.255$   
 $f_c = 33.00$   
 $\phi (5A.5, \text{TB DY}) = 0.002$   
 Final value of  $\phi$ :  $\phi^* = \text{shear\_factor} * \text{Max}(\phi, \phi_c) = 0.00514506$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TB DY:  $\phi = 0.00514506$   
 $\phi (5.4c) = 0.00169139$   
 $\phi (5.4d), \text{TB DY} = (\phi_1 * A_{ext} + \phi_2 * A_{int}) / A_{sec} = 0.14776895$   
 $\phi_1 = 0.14776895$   
 $b_o_1 = 340.00$   
 $h_o_1 = 610.00$   
 $b_{i2_1} = 975400.00$   
 $\phi_2 = \text{Max}(\phi_1, \phi_2) = 0.14776895$   
 $b_o_2 = 192.00$   
 $h_o_2 = 492.00$   
 $b_{i2_2} = 557856.00$   
 $\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.25908$   
 Expression ((5.4d), TB DY) for  $\phi_{sh, \min} * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

---

$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.25223$   
 $\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 No stirrups,  $n_{s\_1} = 2.00$   
 $h_1 = 670.00$   
 $\phi_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$   
 $A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$   
 No stirrups,  $n_{s\_2} = 2.00$   
 $h_2 = 500.00$

---

$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.25908$   
 $\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 No stirrups,  $n_{s\_1} = 2.00$   
 $h_1 = 400.00$   
 $\phi_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$   
 $A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$   
 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), TB DY), TB DY:  $\phi_c = 0.002$   
 $\phi_c = \text{confinement factor} = 1.00$   
 $y_1 = 0.0025$   
 $sh_1 = 0.008$   
 $ft_1 = 833.34$   
 $fy_1 = 694.45$   
 $su_1 = 0.032$

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  $fs_1 = (fs_{\text{jacket}} * A_{sl, \text{ten, jacket}} + fs_{\text{core}} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 694.45$

```

with Es1 = (Esjacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 833.34
fy2 = 694.45
su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of 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 = (fsjacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Esjacket*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 = (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) = 0.10623177
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) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
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:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$\alpha (5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.00514506$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.00514506$$

$$\omega_e (5.4c) = 0.00169139$$

$$\alpha_e ((5.4d), \text{TBDY}) = (\alpha_e1 * A_{ext} + \alpha_e2 * A_{int}) / A_{sec} = 0.14776895$$

$$\alpha_e1 = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

$$\alpha_e2 = \text{Max}(\alpha_e1, \alpha_e2) = 0.14776895$$

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

$$\phi_{sh,min} * F_{ywe} = \text{Min}(\phi_{sh,x} * F_{ywe}, \phi_{sh,y} * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for  $\phi_{sh,min} * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{sh,x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.25223$$

$$\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{sh,y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.25908$$

$$\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$f_{t1} = 833.34$$

$$f_{y1} = 694.45$$

$$s_{u1} = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $su_1 = 0.4 \cdot esu_{1,nominal} ((5.5), TBDY) = 0.032$   
 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  $fs_1 = (fs_{jacket} \cdot Asl_{ten,jacket} + fs_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 694.45$   
 with  $Es_1 = (Es_{jacket} \cdot Asl_{ten,jacket} + Es_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 200000.00$   
 $y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$   
 $fy_2 = 694.45$   
 $su_2 = 0.032$   
 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  
 $l_o/l_{ou,min} = l_b/l_{b,min} = 1.00$   
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$   
 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  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , 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  
 $l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 694.45$   
 with  $Esv = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$   
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.05957415$   
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.10623177$   
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.03374111$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.0736092$   
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.13125889$   
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.04169017$   
 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  $l_b/l_d$

Adequate Lap Length:  $l_b/l_d \geq 1$

## 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:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$cc \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } cu: cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00514506$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } cu = 0.00514506$$

$$we \text{ (5.4c)} = 0.00169139$$

$$ase \text{ ((5.4d), TBDY)} = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo\_1 = 340.00$$

$$ho\_1 = 610.00$$

$$bi2\_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo\_2 = 192.00$$

$$ho\_2 = 492.00$$

$$bi2\_2 = 557856.00$$

$$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.25908$$

Expression ((5.4d), TBDY) for  $psh_{min} * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25223$$

$$ps1 \text{ (external)} = (Ash1 * h1 / s1) / A_{sec} = 0.00261799$$

$$Ash1 = Astir\_1 * ns\_1 = 157.0796$$

$$\text{No stirrups, } ns\_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (Ash2 * h2 / s2) / A_{sec} = 0.00062519$$

$$Ash2 = Astir\_2 * ns\_2 = 100.531$$

$$\text{No stirrups, } ns\_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25908$$

$$ps1 \text{ (external)} = (Ash1 * h1 / s1) / A_{sec} = 0.00156298$$

$$Ash1 = Astir\_1 * ns\_1 = 157.0796$$

$$\text{No stirrups, } ns\_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 * h2 / s2) / A_{sec} = 0.00025008$$

$$Ash2 = Astir\_2 * ns\_2 = 100.531$$

$$\text{No stirrups, } ns\_2 = 2.00$$

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 833.34$$

```

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) = 0.10623177
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) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    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 ' $V_w + f_v V_f$ ' 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  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / \mu < 1 = 1.00$   
 $\mu = 1.0197E+006$   
 $V_u = 9840.632$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 349068.643$   
 $V_{s1} = 311834.654$  is calculated for jacket, with:  
 $d = 536.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17, 10.3.4)  
 $V_{s2} = 37233.989$  is calculated for jacket, with:  
 $d_2 = 400.00$   
 $A_v = 100530.965$   
 $f_y = 555.56$   
 $s = 300.00$   
 $V_{s2}$  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 ' $V_w + f_v V_f$ ' 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  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / \mu < 1 = 1.00$   
 $\mu = 1.0197E+006$   
 $V_u = 9840.634$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 349068.643$   
 $V_{s1} = 311834.654$  is calculated for jacket, with:  
 $d = 536.00$

Av = 157079.633

fy = 555.56

s = 150.00

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, = 0.85

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

New material of Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$

Existing Column

New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 694.45$

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length,  $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ( $l_o/l_{ou}, \min > 1$ )

No FRP Wrapping

-----  
Stepwise Properties

-----  
At local axis: 2

EDGE -A-  
 Shear Force,  $V_a = 1.8202823E-014$   
 EDGE -B-  
 Shear Force,  $V_b = -1.8202823E-014$   
 BOTH EDGES  
 Axial Force,  $F = -2237.255$   
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
   -Tension:  $As_t = 709.9999$   
   -Compression:  $As_c = 1668.186$   
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $As_{t,ten} = 911.0619$   
   -Compression:  $As_{l,com} = 911.0619$   
   -Middle:  $As_{l,mid} = 556.0619$

-----  
 -----  
 Calculation of Shear Capacity ratio ,  $V_e/V_r = 0.53480887$   
 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  
 $V_1 = 1.8202823E-014$ , is the shear force acting at edge 1 for the static loading combination  
 $V_2 = -1.8202823E-014$ , 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  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00514506$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $\phi_u = 0.00514506$   
 $w_e$  (5.4c) = 0.00169139  
 $ase$  ((5.4d), TBDY) =  $(ase1 \cdot A_{ext} + ase2 \cdot A_{int})/A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo\_1 = 340.00$   
 $ho\_1 = 610.00$   
 $bi2\_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$

$psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.25908$   
 Expression ((5.4d), TBDY) for  $psh,min*Fywe$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.25223$   
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00261799$   
 $Ash1 = Astir\_1*ns\_1 = 157.0796$   
 No stirrups,  $ns\_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00062519$   
 $Ash2 = Astir\_2*ns\_2 = 100.531$   
 No stirrups,  $ns\_2 = 2.00$   
 $h2 = 500.00$

$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.25908$   
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00156298$   
 $Ash1 = Astir\_1*ns\_1 = 157.0796$   
 No stirrups,  $ns\_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00025008$   
 $Ash2 = Astir\_2*ns\_2 = 100.531$   
 No stirrups,  $ns\_2 = 2.00$   
 $h2 = 200.00$

$Asec = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fywe1 = 694.45$   
 $fywe2 = 694.45$   
 $fce = 33.00$

From ((5.A5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$

$y1 = 0.0025$   
 $sh1 = 0.008$   
 $ft1 = 833.34$   
 $fy1 = 694.45$   
 $su1 = 0.032$

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) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    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) = 0.00514506
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00514506
we (5.4c) = 0.00169139
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00

```

$bi2\_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$   
 $psh, \min * Fywe = \text{Min}(psh, x * Fywe, psh, y * Fywe) = 1.25908$   
 Expression ((5.4d), TBDY) for  $psh, \min * Fywe$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh\_x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 2.25223$   
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00261799$   
 $Ash1 = Astir\_1 * ns\_1 = 157.0796$   
 No stirrups,  $ns\_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00062519$   
 $Ash2 = Astir\_2 * ns\_2 = 100.531$   
 No stirrups,  $ns\_2 = 2.00$   
 $h2 = 500.00$

$psh\_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.25908$   
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00156298$   
 $Ash1 = Astir\_1 * ns\_1 = 157.0796$   
 No stirrups,  $ns\_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00025008$   
 $Ash2 = Astir\_2 * ns\_2 = 100.531$   
 No stirrups,  $ns\_2 = 2.00$   
 $h2 = 200.00$

$Asec = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fywe1 = 694.45$   
 $fywe2 = 694.45$   
 $fce = 33.00$

From ((5.A5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$

$y1 = 0.0025$   
 $sh1 = 0.008$   
 $ft1 = 833.34$   
 $fy1 = 694.45$   
 $su1 = 0.032$

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,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) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09611636
2 = Asl,com/(b*d)*(fs2/fc) = 0.09611636
v = Asl,mid/(b*d)*(fsv/fc) = 0.05866412
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.13857861
Mu = MRc (4.14) = 3.0743E+008
u = su (4.1) = 0.00010406

```

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

```

u = 0.00010406
Mu = 3.0743E+008

```

with full section properties:

```

b = 670.00
d = 357.00
d' = 43.00
v = 0.00028344
N = 2237.255
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00514506
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00514506

```

$w_e (5.4c) = 0.00169139$   
 $ase ((5.4d), TBDY) = (ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo\_1 = 340.00$   
 $ho\_1 = 610.00$   
 $bi2\_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$

$psh, min \cdot F_{ywe} = \text{Min}(psh, x \cdot F_{ywe}, psh, y \cdot F_{ywe}) = 1.25908$   
 Expression ((5.4d), TBDY) for  $psh, min \cdot F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh, x \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 2.25223$   
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.00261799$   
 $Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$   
 No stirrups,  $ns\_1 = 2.00$   
 $h1 = 670.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00062519$   
 $Ash2 = Astir\_2 \cdot ns\_2 = 100.531$   
 No stirrups,  $ns\_2 = 2.00$   
 $h2 = 500.00$

$psh, y \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 1.25908$   
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.00156298$   
 $Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$   
 No stirrups,  $ns\_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00025008$   
 $Ash2 = Astir\_2 \cdot ns\_2 = 100.531$   
 No stirrups,  $ns\_2 = 2.00$   
 $h2 = 200.00$

$A_{sec} = 268000.00$

$s1 = 150.00$

$s2 = 300.00$

$fywe1 = 694.45$

$fywe2 = 694.45$

$f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY:  $cc = 0.002$

$c = \text{confinement factor} = 1.00$

$y1 = 0.0025$

$sh1 = 0.008$

$ft1 = 833.34$

$fy1 = 694.45$

$su1 = 0.032$

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

$lo/lo, min = lb/ld = 1.00$

$su1 = 0.4 \cdot esu1\_nominal ((5.5), TBDY) = 0.032$

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 Shear\_factor = 1.00

$lo/lo, min = lb/lb, min = 1.00$

$su_2 = 0.4 * esu_{2\_nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esu_{2\_nominal} = 0.08$ ,  
 For calculation of  $esu_{2\_nominal}$  and  $y_2, sh_2, ft_2, fy_2$ , it is considered  
 characteristic value  $fsy_2 = fs_2/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_2 = (fs_{jacket} * Asl_{com,jacket} + fs_{core} * Asl_{com,core}) / Asl_{com} = 694.45$   
 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  
 $lo/lo_{u,min} = lb/ld = 1.00$   
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fsyv = fs_v/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fsyv = fs_v/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_v = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 694.45$   
 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:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.09611636$   
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.09611636$   
 $v = Asl_{mid} / (b * d) * (fs_v / fc) = 0.05866412$   
 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  $lb/ld$

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Adequate Lap Length:  $lb/ld \geq 1$

-----

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Calculation of  $Mu_2$ -

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Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:

$u = 0.00010406$   
 $Mu = 3.0743E+008$

-----

with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.00028344$   
 $N = 2237.255$

$f_c = 33.00$   
 $c_o (5A.5, TBDY) = 0.002$   
 Final value of  $c_u$ :  $c_u^* = \text{shear\_factor} * \text{Max}(c_u, c_o) = 0.00514506$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $c_u = 0.00514506$   
 $w_e (5.4c) = 0.00169139$   
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$   
 $a_{se1} = 0.14776895$   
 $b_o_1 = 340.00$   
 $h_o_1 = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$   
 $b_o_2 = 192.00$   
 $h_o_2 = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25908$   
 Expression ((5.4d), TBDY) for  $p_{sh, \min} * F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.25223$   
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 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.A5), TBDY), TBDY:  $c_c = 0.002$   
 $c = \text{confinement factor} = 1.00$

$y_1 = 0.0025$   
 $sh_1 = 0.008$   
 $ft_1 = 833.34$   
 $fy_1 = 694.45$   
 $su_1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$

$l_o / l_{ou, \min} = l_b / l_d = 1.00$

$su_1 = 0.4 * esu_{1\_nominal} ((5.5), TBDY) = 0.032$

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  $fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 694.45$

with  $Es_1 = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$

$y_2 = 0.0025$   
 $sh_2 = 0.008$   
 $ft_2 = 833.34$   
 $fy_2 = 694.45$

```

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) = 0.08015524
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) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
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/lb

Adequate Lap Length: lb/lb >= 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:  $f'_c = (f'_{c\_jacket} \cdot Area\_jacket + f'_{c\_core} \cdot Area\_core) / Area\_section = 33.00$ , but  $f_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $p_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 4.0861879E-011$   
 $V_u = 1.8202823E-014$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$   
 $V_{s1} = 186169.943$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 0.00$  is calculated for jacket, with:  
 $d_2 = 160.00$   
 $A_v = 100530.965$   
 $f_y = 555.56$   
 $s = 300.00$   
 $V_{s2}$  is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)  
 $V_f$  ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

Calculation of Shear Strength at edge 2,  $V_{r2} = 383231.42$   
 $V_{r2} = V_n$  ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' $V_w$ ' is replaced by ' $V_w + f \cdot V_f$ '  
where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 197061.477$   
 $= 1$  (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot Area\_jacket + f'_{c\_core} \cdot Area\_core) / Area\_section = 33.00$ , but  $f_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $p_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 1.3749363E-011$   
 $V_u = 1.8202823E-014$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$   
 $V_{s1} = 186169.943$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 0.00$  is calculated for jacket, with:  
 $d = 160.00$   
 $A_v = 100530.965$   
 $f_y = 555.56$   
 $s = 300.00$   
 $V_{s2}$  is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)  
 $V_f$  ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440:  $V_s + V_f \leq 818179.336$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1  
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1



At local axis: 3  
Integration Section: (b)  
Section Type: rcjars

#### Constant Properties

Knowledge Factor,  $\gamma = 0.85$   
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.  
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17  
Consequently:  
Jacket  
New material of Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$   
New material of Secondary 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 Secondary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$   
New material of Secondary 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,  $L = 3000.00$   
Secondary Member  
Ribbed Bars  
Ductile Steel  
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)  
Longitudinal Bars With Ends Lapped Starting at the End Sections  
Adequate Lap Length ( $l_b/d \geq 1$ )  
No FRP Wrapping

#### Stepwise Properties

Bending Moment,  $M = -2.4334440E-011$   
Shear Force,  $V_2 = 1.6099959E-014$   
Shear Force,  $V_3 = 15660.98$   
Axial Force,  $F = -3615.026$   
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  $u_R = 1.0^*$   $u = 0.03344037$   
 $u = \gamma + p = 0.03344037$

- Calculation of  $\gamma$  -

$y = (M_y * L_s / 3) / E_{eff} = 0.00344037$  ((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 -

$y = \text{Min}(y_{ten}, y_{com})$   
 $y_{ten} = 1.0019692E-005$   
 with  $f_y = 555.56$   
 $d = 357.00$   
 $y = 0.223434$   
 $A = 0.00996987$   
 $B = 0.00559732$   
 with  $p_t = 0.00380895$   
 $p_c = 0.00380895$   
 $p_v = 0.00232477$   
 $N = 3615.026$   
 $b = 670.00$   
 $" = 0.12044818$   
 $y_{comp} = 2.7622786E-005$   
 with  $f_c = 33.00$   
 $E_c = 26999.444$   
 $y = 0.22309812$   
 $A = 0.00990831$   
 $B = 0.00557012$   
 with  $E_s = 200000.00$

#### Calculation of ratio $I_b/I_d$

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,  $\phi_y < 2$  (table 10-6, ASCE 41-17)  
 $= 3.2884744E-022$
- Stirrup Spacing  $\leq d/2$   
 $d = d_{external} = 357.00$   
 $s = s_{external} = 150.00$
- Strength provided by hoops  $V_s < 3/4 * \text{design Shear}$   
 $V_s = 215957.134$ , already given in calculation of shear control ratio  
 design Shear =  $1.6099959E-014$
- $(\phi - \phi') / \phi_{bal} = -0.23508921$   
 $= A_{st} / (b_w * d) = 0.00296835$   
 Tension Reinf Area:  $A_{st} = 709.9999$   
 $\phi' = A_{sc} / (b_w * d) = 0.00697431$   
 Compression Reinf Area:  $A_{sc} = 1668.186$
- From (B-1), ACI 318-11:  $\phi_{bal} = 0.01704017$   
 $f_c = (f_{c\_jacket} * \text{Area}_{jacket} + f_{c\_core} * \text{Area}_{core}) / \text{section\_area} = 33.00$   
 $f_y = f_{y\_jacket\_bars} = 555.56$   
 From 10.2.7.3, ACI 318-11:  $\phi = 0.65$   
 From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000 / (87000 + f_y) = c_b/dt = 0.003 / (0.003 + \phi) = 0.51922877$   
 $\phi = 0.0027778$
- $V / (b_w * d * f_c^{0.5}) = 1.4110682E-019$ , NOTE: units in lb & in

bw = 670.00

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End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)

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