

# Detailed Member Calculations

**Units: N&mm**

**Regulation: ASCE 41-17**

## Calculation No. 1

beam B1, Floor 1

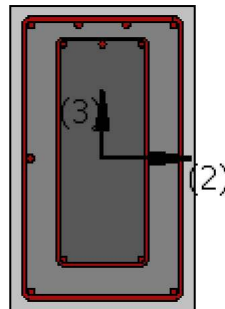
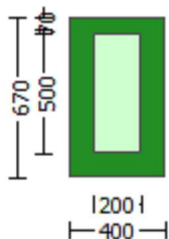
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

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,  $\gamma = 0.90$

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

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$   
 Steel Elasticity,  $E_s = 200000.00$   
 Existing Column  
 Existing material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 16.00$   
 Existing material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 400.00$   
 Concrete Elasticity,  $E_c = 21019.039$   
 Steel Elasticity,  $E_s = 200000.00$   
 External Height,  $H = 670.00$   
 External Width,  $W = 400.00$   
 Internal Height,  $H = 500.00$   
 Internal Width,  $W = 200.00$   
 Cover Thickness,  $c = 25.00$   
 Element Length,  $L = 3000.00$   
 Primary Member  
 Ribbed Bars  
 Ductile Steel  
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)  
 Longitudinal Bars With Ends Lapped Starting at the End Sections  
 Lap Length  $l_o = l_b = 300.00$   
 No FRP Wrapping

#### Stepwise Properties

EDGE -A-  
 Bending Moment,  $M_a = -1.7152371E-011$   
 Shear Force,  $V_a = 7.3183079E-015$   
 EDGE -B-  
 Bending Moment,  $M_b = 3.8904059E-011$   
 Shear Force,  $V_b = -7.3183079E-015$   
 BOTH EDGES  
 Axial Force,  $F = -7206.737$   
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
 -Tension:  $A_{st} = 709.9999$   
 -Compression:  $A_{sc} = 1668.186$   
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
 -Tension:  $A_{st,ten} = 911.0619$   
 -Compression:  $A_{st,com} = 911.0619$   
 -Middle:  $A_{st,mid} = 556.0619$   
 Mean Diameter of Tension Reinforcement,  $Db_{L,ten} = 15.20$

Existing component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $V_R = *V_n = 294422.714$   
 $V_n ((22.5.1.1), ACI 318-14) = 327136.349$

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:  $V_c = 159584.741$   
 $= 1$  (normal-weight concrete)  
 Mean concrete strength:  $f'_c = (f'_{c\_jacket} * Area\_jacket + f'_{c\_core} * Area\_core) / Area\_section = 21.64179$ , but  $f'_c^{0.5} < = 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $p_w = A_s / (b_w * d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u * d / M_u < 1 = 0.00$   
 $M_u = 1.7152371E-011$   
 $V_u = 7.3183079E-015$   
 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:

$d = 160.00$

$A_v = 100530.965$

$f_y = 400.00$

$s = 300.00$

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:  $V_s + V_f \leq 662579.716$

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

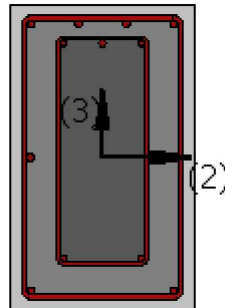
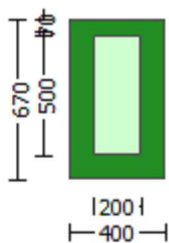
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (  $\mu$  )

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,  $\phi = 0.90$

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

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Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
#####
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
#####
External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping
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Stepwise Properties
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At local axis: 3
EDGE -A-
Shear Force, Va = 9840.632
EDGE -B-
Shear Force, Vb = 9840.634
BOTH EDGES
Axial Force, F = -2285.866
Longitudinal Reinforcement Area Distribution (in 2 divisions)
  -Tension: Aslt = 709.9999
  -Compression: Aslc = 1668.186
Longitudinal Reinforcement Area Distribution (in 3 divisions)
  -Tension: Asl,ten = 709.9999
  -Compression: Asl,com = 1266.062
  -Middle: Asl,mid = 402.1239
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Calculation of Shear Capacity ratio , Ve/Vr = 0.49656722
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln ± vu*ln/2 = 266008.163
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.8425E+008
  Mu1+ = 2.2952E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
  which is defined for the static loading combination
  Mu1- = 3.8425E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
  direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 3.8425E+008
  Mu2+ = 2.2952E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
  which is defined for the the static loading combination
  Mu2- = 3.8425E+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
± vu*ln = (|V1| + |V2|)/2
with

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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:

$$\phi_u = 1.2638035E-005$$

$$M_u = 2.2952E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027619$$

$$N = 2285.866$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.00512221$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.00512221$$

$$\phi_{ue} \text{ (5.4c)} = 0.00164473$$

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

$$\phi_{se1} = 0.14776895$$

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

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

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

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

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

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

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

$$\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.22434$$

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)

$$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.16539$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.22434$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00154581$$

$$sh_1 = 0.00494661$$

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ft1 = 470.5847
fy1 = 392.1539
su1 = 0.00695956
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 0.34790516
    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 = 392.1539
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00154581
sh2 = 0.00494661
ft2 = 477.682
fy2 = 398.0683
su2 = 0.00695956
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.34790516
    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 = 398.0683
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00154581
shv = 0.00494661
ftv = 515.2755
fyv = 429.3962
suv = 0.00695956
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 0.34790516
    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 = 429.3962
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.03364135
2 = Asl,com/(b*d)*(fs2/fc) = 0.06089352
v = Asl,mid/(b*d)*(fsv/fc) = 0.02086299
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) = 0.0415669
    2 = Asl,com/(b*d)*(fs2/fc) = 0.0752394
    v = Asl,mid/(b*d)*(fsv/fc) = 0.0257781
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1217168
Mu = MRc (4.14) = 2.2952E+008

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$$u = su(4.1) = 1.2638035E-005$$

Calculation of ratio lb/d

Lap Length: lb/d = 0.34790516

$$lb = 300.00$$

$$ld = 862.304$$

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$$= 1$$

$$db = 15.23077$$

Mean strength value of all re-bars: fy = 645.3439

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$Ktr = 2.64216$$

$$n = 13.00$$

Calculation of Mu1-

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

$$u = 1.3095001E-005$$

$$Mu = 3.8425E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027619$$

$$N = 2285.866$$

$$fc = 33.00$$

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

Final value of cu: cu\* = shear\_factor \* Max( cu, cc) = 0.00512221

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

From (5.4b), TBDY: cu = 0.00512221

we (5.4c) = 0.00164473

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

$$ase1 = 0.14776895$$

$$bo\_1 = 340.00$$

$$ho\_1 = 610.00$$

$$bi2\_1 = 975400.00$$

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

$$bo\_2 = 192.00$$

$$ho\_2 = 492.00$$

$$bi2\_2 = 557856.00$$

$$psh\_min * Fywe = \text{Min}(psh\_x * Fywe, psh\_y * Fywe) = 1.22434$$

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)

$$psh\_x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 2.16539$$

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

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

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

$$h1 = 670.00$$

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

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

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

$$h2 = 500.00$$

$$psh\_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.22434$$

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

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

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

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 $Asec = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fywe1 = 694.45$   
 $fywe2 = 555.55$   
 $fce = 33.00$

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

$y1 = 0.00154581$   
 $sh1 = 0.00494661$

$ft1 = 477.682$

$fy1 = 398.0683$

$su1 = 0.00695956$

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

$lo/lo_{u,min} = lb/ld = 0.34790516$

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

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

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

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

with  $fs1 = (fs_{jacket} \cdot Asl_{ten,jacket} + fs_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 398.0683$

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

$y2 = 0.00154581$

$sh2 = 0.00494661$

$ft2 = 470.5847$

$fy2 = 392.1539$

$su2 = 0.00695956$

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

$lo/lo_{u,min} = lb/lb_{min} = 0.34790516$

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

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.

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

with  $fs2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 392.1539$

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

$yv = 0.00154581$

$shv = 0.00494661$

$ftv = 515.2755$

$fyv = 429.3962$

$suv = 0.00695956$

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

$lo/lo_{u,min} = lb/ld = 0.34790516$

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

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  $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 429.3962$

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

$1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fce) = 0.06089352$

$2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fce) = 0.03364135$

$v = Asl_{mid} / (b \cdot d) \cdot (fsv / fce) = 0.02086299$



and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

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

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

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

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.0752394$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.0415669$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.0257781$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$s_u (4.9) = 0.1523656$$

$$M_u = M_{Rc} (4.14) = 3.8425E+008$$

$$u = s_u (4.1) = 1.3095001E-005$$

Calculation of ratio  $l_b/l_d$

Lap Length:  $l_b/l_d = 0.34790516$

$$l_b = 300.00$$

$$l_d = 862.304$$

Calculation of  $l_b, \min$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars:  $f_y = 645.3439$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of  $M_{u2+}$

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

$$u = 1.2638035E-005$$

$$M_u = 2.2952E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027619$$

$$N = 2285.866$$

$$f_c = 33.00$$

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

$$\text{Final value of } cu: cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00512221$$

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

$$\text{From (5.4b), TBDY: } cu = 0.00512221$$

$$\text{we (5.4c) } = 0.00164473$$

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

$$ase1 = 0.14776895$$

$$bo\_1 = 340.00$$

$$ho\_1 = 610.00$$

$$bi2\_1 = 975400.00$$

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

$$bo\_2 = 192.00$$

$$ho\_2 = 492.00$$

$$bi2\_2 = 557856.00$$

$psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.22434$   
 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)

---

$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.16539$   
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00261799$   
 $Ash1 = Astir\_1*ns\_1 = 157.0796$   
 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,  $ns\_2 = 2.00$   
 $h2 = 500.00$

---

$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.22434$   
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00156298$   
 $Ash1 = Astir\_1*ns\_1 = 157.0796$   
 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,  $ns\_2 = 2.00$   
 $h2 = 200.00$

---

$Asec = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fywe1 = 694.45$   
 $fywe2 = 555.55$   
 $fce = 33.00$

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

$y1 = 0.00154581$   
 $sh1 = 0.00494661$   
 $ft1 = 470.5847$   
 $fy1 = 392.1539$   
 $su1 = 0.00695956$

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

$lo/lou,min = lb/ld = 0.34790516$

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

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  $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 392.1539$

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

$y2 = 0.00154581$   
 $sh2 = 0.00494661$   
 $ft2 = 477.682$   
 $fy2 = 398.0683$   
 $su2 = 0.00695956$

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

$lo/lou,min = lb/lb,min = 0.34790516$

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

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  $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 398.0683$

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

$yv = 0.00154581$   
 $shv = 0.00494661$   
 $ftv = 515.2755$

```

fyv = 429.3962
suv = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lo,min = lb/ld = 0.34790516
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 = 429.3962
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.03364135
2 = Asl,com/(b*d)*(fs2/fc) = 0.06089352
v = Asl,mid/(b*d)*(fsv/fc) = 0.02086299
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) = 0.0415669
2 = Asl,com/(b*d)*(fs2/fc) = 0.0752394
v = Asl,mid/(b*d)*(fsv/fc) = 0.0257781
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1217168
Mu = MRc (4.14) = 2.2952E+008
u = su (4.1) = 1.2638035E-005
-----

Calculation of ratio lb/ld
-----
Lap Length: lb/ld = 0.34790516
lb = 300.00
ld = 862.304
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 645.3439
t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00
-----

Calculation of Mu2-
-----

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.3095001E-005
Mu = 3.8425E+008
-----
with full section properties:
b = 400.00
d = 627.00
d' = 43.00

```

$v = 0.00027619$   
 $N = 2285.866$   
 $f_c = 33.00$   
 $\phi (5A.5, \text{TB DY}) = 0.002$   
 Final value of  $\phi$ :  $\phi = \text{shear\_factor} * \text{Max}(\phi_c, \phi_s) = 0.00512221$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TB DY:  $\phi = 0.00512221$   
 $\phi (5.4c) = 0.00164473$   
 $\phi ((5.4d), \text{TB DY}) = (\phi_1 * A_{ext} + \phi_2 * A_{int}) / A_{sec} = 0.14776895$   
 $\phi_1 = 0.14776895$   
 $b_o_1 = 340.00$   
 $h_o_1 = 610.00$   
 $b_{i2_1} = 975400.00$   
 $\phi_2 = \text{Max}(\phi_1, \phi_2) = 0.14776895$   
 $b_o_2 = 192.00$   
 $h_o_2 = 492.00$   
 $b_{i2_2} = 557856.00$   
 $\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.22434$   
 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)

$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.16539$   
 $\phi_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$   
 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,  $n_{s_2} = 2.00$   
 $h_2 = 500.00$

$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.22434$   
 $\phi_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$   
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$   
 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,  $n_{s_2} = 2.00$   
 $h_2 = 200.00$

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

$f_{ywe1} = 694.45$   
 $f_{ywe2} = 555.55$   
 $f_{ce} = 33.00$

From ((5.A.5), TB DY), TB DY:  $\phi_c = 0.002$   
 $\phi_c = \text{confinement factor} = 1.00$

$y_1 = 0.00154581$   
 $sh_1 = 0.00494661$   
 $ft_1 = 477.682$   
 $fy_1 = 398.0683$   
 $su_1 = 0.00695956$

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

$\phi_o / \phi_{ou, \min} = \phi_b / \phi_d = 0.34790516$   
 $su_1 = 0.4 * \phi_{su1\_nominal} ((5.5), \text{TB DY}) = 0.032$

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  $fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 398.0683$

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

$y_2 = 0.00154581$   
 $sh_2 = 0.00494661$

```

ft2 = 470.5847
fy2 = 392.1539
su2 = 0.00695956
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.34790516
    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 = 392.1539
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
    yv = 0.00154581
    shv = 0.00494661
ftv = 515.2755
fyv = 429.3962
suv = 0.00695956
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 0.34790516
    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 = 429.3962
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.06089352
    2 = Asl,com/(b*d)*(fs2/fc) = 0.03364135
    v = Asl,mid/(b*d)*(fsv/fc) = 0.02086299
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) = 0.0752394
    2 = Asl,com/(b*d)*(fs2/fc) = 0.0415669
    v = Asl,mid/(b*d)*(fsv/fc) = 0.0257781

```

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

```

---->
v < vs,y2 - LHS eq.(4.5) is satisfied
---->
su (4.9) = 0.1523656
Mu = MRc (4.14) = 3.8425E+008
u = su (4.1) = 1.3095001E-005

```

Calculation of ratio lb/lb

```

Lap Length: lb/lb = 0.34790516
lb = 300.00
lb = 862.304
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 645.3439
t = 1.16154
s = 0.80
e = 1.00
cb = 25.00

```

Ktr = 2.64216  
n = 13.00

Calculation of Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 535694.165$

Calculation of Shear Strength at edge 1,  $V_{r1} = 535694.165$   
 $V_{r1} = V_n$  ((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:  $V_c = 194072.856$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot \text{Area\_jacket} + f'_{c\_core} \cdot \text{Area\_core}) / \text{Area\_section} = 28.14925$ , 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  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / M_u < 1 = 1.00$   
 $M_u = 1.1086 \times 10^6$   
 $V_u = 9840.632$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 341621.309$   
 $V_{s1} = 311834.654$  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)  
 $V_{s2} = 29786.655$  is calculated for jacket, with:  
 $d_2 = 400.00$   
 $A_v = 100530.965$   
 $f_y = 444.44$   
 $s = 300.00$   
 $V_{s2}$  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:  $V_s + V_f \leq 755657.47$

Calculation of Shear Strength at edge 2,  $V_{r2} = 535694.165$   
 $V_{r2} = V_n$  ((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:  $V_c = 194072.856$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot \text{Area\_jacket} + f'_{c\_core} \cdot \text{Area\_core}) / \text{Area\_section} = 28.14925$ , 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  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / M_u < 1 = 1.00$   
 $M_u = 1.1086 \times 10^6$   
 $V_u = 9840.634$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 341621.309$   
 $V_{s1} = 311834.654$  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)  
 $V_{s2} = 29786.655$  is calculated for jacket, with:

d = 400.00  
Av = 100530.965  
fy = 444.44  
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 <= 755657.47

-----  
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,  $\phi = 0.90$   
Mean strength values are used for both shear and moment calculations.  
Consequently:  
Jacket  
New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$   
New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$   
Concrete Elasticity,  $E_c = 26999.444$   
Steel Elasticity,  $E_s = 200000.00$   
Existing Column  
Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 20.00$   
Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 444.44$   
Concrete Elasticity,  $E_c = 21019.039$   
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  
Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 555.55$   
#####  
External Height,  $H = 670.00$   
External Width,  $W = 400.00$   
Internal Height,  $H = 500.00$   
Internal Width,  $W = 200.00$   
Cover Thickness,  $c = 25.00$   
Mean Confinement Factor overall section = 1.00  
Element Length,  $L = 3000.00$   
Primary Member  
Ribbed Bars  
Ductile Steel  
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)  
Longitudinal Bars With Ends Lapped Starting at the End Sections  
Lap Length  $l_o = 300.00$   
No FRP Wrapping

-----  
Stepwise Properties

-----  
At local axis: 2  
EDGE -A-  
Shear Force,  $V_a = 4.8511603E-015$   
EDGE -B-  
Shear Force,  $V_b = -4.8511603E-015$   
BOTH EDGES

Axial Force,  $F = -2285.866$   
 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,  $V_e/V_r = 0.30156355$   
 Member Controlled by Flexure ( $V_e/V_r < 1$ )  
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 111027.496$   
 with  
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 1.6654E+008$   
 $\mu_{u1+} = 1.6654E+008$ , 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  
 $\mu_{u1-} = 1.6654E+008$ , 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  
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 1.6654E+008$   
 $\mu_{u2+} = 1.6654E+008$ , 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  
 $\mu_{u2-} = 1.6654E+008$ , 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  
 $V_1 = 4.8511603E-015$ , is the shear force acting at edge 1 for the static loading combination  
 $V_2 = -4.8511603E-015$ , 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:  
 $\phi_u = 2.2916591E-005$   
 $M_u = 1.6654E+008$

with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.0002896$   
 $N = 2285.866$   
 $f_c = 33.00$   
 $\phi_c \text{ (5A.5, TBDY)} = 0.002$   
 Final value of  $\phi_{cu}$ :  $\phi_{cu}^* = \text{shear\_factor} \cdot \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00512221$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $\phi_{cu} = 0.00512221$   
 $\phi_{we} \text{ (5.4c)} = 0.00164473$   
 $\phi_{ase} \text{ ((5.4d), TBDY)} = (\phi_{ase1} \cdot A_{ext} + \phi_{ase2} \cdot A_{int})/A_{sec} = 0.14776895$   
 $\phi_{ase1} = 0.14776895$   
 $\phi_{bo\_1} = 340.00$   
 $\phi_{ho\_1} = 610.00$   
 $\phi_{bi2\_1} = 975400.00$   
 $\phi_{ase2} = \text{Max}(\phi_{ase1}, \phi_{ase2}) = 0.14776895$   
 $\phi_{bo\_2} = 192.00$   
 $\phi_{ho\_2} = 492.00$   
 $\phi_{bi2\_2} = 557856.00$   
 $\phi_{psh,min} \cdot F_{ywe} = \text{Min}(\phi_{psh,x} \cdot F_{ywe}, \phi_{psh,y} \cdot F_{ywe}) = 1.22434$   
 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)

$\phi_{psh,x} \cdot F_{ywe} = \phi_{psh1} \cdot F_{ywe1} + \phi_{psh2} \cdot F_{ywe2} = 2.16539$



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

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

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

$$h1 = 670.00$$

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

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

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

$$h2 = 500.00$$

$$psh_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.22434$$

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

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

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

$$h1 = 400.00$$

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

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

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

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 555.55$$

$$fce = 33.00$$

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

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

$$y1 = 0.00154581$$

$$sh1 = 0.00494661$$

$$ft1 = 480.4475$$

$$fy1 = 400.3729$$

$$su1 = 0.00695956$$

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

$$lo/lou, \min = lb/ld = 0.34790516$$

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

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

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

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

$$\text{with } fs1 = (fs_{\text{jacket}} \cdot Asl, \text{ten, jacket} + fs_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 400.3729$$

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

$$y2 = 0.00154581$$

$$sh2 = 0.00494661$$

$$ft2 = 480.4475$$

$$fy2 = 400.3729$$

$$su2 = 0.00695956$$

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

$$lo/lou, \min = lb/lb, \min = 0.34790516$$

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

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

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

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

$$\text{with } fs2 = (fs_{\text{jacket}} \cdot Asl, \text{com, jacket} + fs_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 400.3729$$

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

$$yv = 0.00154581$$

$$shv = 0.00494661$$

$$ftv = 486.7441$$

$$fyv = 405.62$$

$$suv = 0.00695956$$

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

$l_o/l_{ou,min} = l_b/l_d = 0.34790516$   
 $suv = 0.4 * esuv\_nominal ((5.5), TBDY) = 0.032$   
 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  $fsv = (fs\_jacket * Asl\_mid,jacket + fs\_mid * Asl\_mid,core) / Asl\_mid = 405.62$   
 with  $Esv = (Es\_jacket * Asl\_mid,jacket + Es\_mid * Asl\_mid,core) / Asl\_mid = 200000.00$   
 $1 = Asl\_ten / (b * d) * (fs1 / fc) = 0.04621209$   
 $2 = Asl\_com / (b * d) * (fs2 / fc) = 0.04621209$   
 $v = Asl\_mid / (b * d) * (fsv / fc) = 0.02857496$

and confined core properties:

$b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl\_ten / (b * d) * (fs1 / fc) = 0.05541419$   
 $2 = Asl\_com / (b * d) * (fs2 / fc) = 0.05541419$   
 $v = Asl\_mid / (b * d) * (fsv / fc) = 0.03426502$

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

--->  
 $v < vs,y2$  - LHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.14932546$   
 $Mu = MRc (4.14) = 1.6654E+008$   
 $u = su (4.1) = 2.2916591E-005$

Calculation of ratio  $l_b/l_d$

Lap Length:  $l_b/l_d = 0.34790516$   
 $l_b = 300.00$   
 $l_d = 862.304$   
 Calculation of  $l_b,min$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.  
 $= 1$   
 $db = 15.23077$   
 Mean strength value of all re-bars:  $fy = 645.3439$   
 $t = 1.16154$   
 $s = 0.80$   
 $e = 1.00$   
 $cb = 25.00$   
 $Ktr = 2.64216$   
 $n = 13.00$

Calculation of  $Mu1$ -

Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:  
 $u = 2.2916591E-005$   
 $Mu = 1.6654E+008$

with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.0002896$   
 $N = 2285.866$   
 $fc = 33.00$   
 $co (5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00512221$

The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $c_u = 0.00512221$   
 $w_e$  (5.4c) = 0.00164473  
 $a_{se}$  ((5.4d), TBDY) =  $(a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int}) / A_{sec} = 0.14776895$   
 $a_{se1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $p_{sh, \min} \cdot F_{ywe} = \text{Min}(p_{sh, x} \cdot F_{ywe}, p_{sh, y} \cdot F_{ywe}) = 1.22434$   
 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)

$p_{sh, x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 2.16539$   
 $p_{s1}$  (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,  $n_{s\_2} = 2.00$   
 $h_2 = 500.00$

$p_{sh, y} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 1.22434$   
 $p_{s1}$  (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,  $n_{s\_2} = 2.00$   
 $h_2 = 200.00$

$A_{sec} = 268000.00$   
 $s_1 = 150.00$   
 $s_2 = 300.00$   
 $f_{ywe1} = 694.45$   
 $f_{ywe2} = 555.55$   
 $f_{ce} = 33.00$

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

$y_1 = 0.00154581$   
 $sh_1 = 0.00494661$   
 $ft_1 = 480.4475$   
 $fy_1 = 400.3729$   
 $su_1 = 0.00695956$

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

$l_o / l_{ou, \min} = l_b / l_d = 0.34790516$

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

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

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

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

with  $fs_1 = (f_{s, \text{jacket}} \cdot A_{s, \text{ten, jacket}} + f_{s, \text{core}} \cdot A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 400.3729$

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

$y_2 = 0.00154581$   
 $sh_2 = 0.00494661$   
 $ft_2 = 480.4475$   
 $fy_2 = 400.3729$   
 $su_2 = 0.00695956$

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

Shear\_factor = 1.00  
 $l_o/l_{o,min} = l_b/l_{b,min} = 0.34790516$   
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esu_{2,nominal} = 0.08$ ,  
 For calculation of  $esu_{2,nominal}$  and  $y_2, sh_2, ft_2, fy_2$ , it is considered  
 characteristic value  $fsy_2 = fs_2/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 400.3729$   
 with  $Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$   
 $y_v = 0.00154581$   
 $sh_v = 0.00494661$   
 $ft_v = 486.7441$   
 $fy_v = 405.62$   
 $suv = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $l_o/l_{o,min} = l_b/l_d = 0.34790516$   
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fsv = fs_v/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fsv = fs_v/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_v = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 405.62$   
 with  $Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$   
 $1 = A_{sl,ten} / (b * d) * (fs_1 / f_c) = 0.04621209$   
 $2 = A_{sl,com} / (b * d) * (fs_2 / f_c) = 0.04621209$   
 $v = A_{sl,mid} / (b * d) * (fs_v / f_c) = 0.02857496$   
 and confined core properties:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten} / (b * d) * (fs_1 / f_c) = 0.05541419$   
 $2 = A_{sl,com} / (b * d) * (fs_2 / f_c) = 0.05541419$   
 $v = A_{sl,mid} / (b * d) * (fs_v / f_c) = 0.03426502$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.14932546$   
 $\mu_u = MR_c (4.14) = 1.6654E+008$   
 $u = su (4.1) = 2.2916591E-005$

#### Calculation of ratio $l_b/l_d$

Lap Length:  $l_b/l_d = 0.34790516$   
 $l_b = 300.00$   
 $l_d = 862.304$   
 Calculation of  $l_{b,min}$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.  
 $= 1$   
 $db = 15.23077$   
 Mean strength value of all re-bars:  $fy = 645.3439$   
 $t = 1.16154$   
 $s = 0.80$   
 $e = 1.00$   
 $cb = 25.00$   
 $K_{tr} = 2.64216$   
 $n = 13.00$

## Calculation of Mu2+

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

$$\phi_u = 2.2916591E-005$$

$$\mu = 1.6654E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0002896$$

$$N = 2285.866$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear\_factor} * \text{Max}(\phi_{cu}, \phi_{co}) = 0.00512221$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00512221$$

$$\phi_{we} (5.4c) = 0.00164473$$

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

$$\phi_{ase1} = 0.14776895$$

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

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

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

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

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

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

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

$$\phi_{psh,min} * F_{ywe} = \text{Min}(\phi_{psh,x} * F_{ywe}, \phi_{psh,y} * F_{ywe}) = 1.22434$$

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)

$$\phi_{psh,x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 2.16539$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$\phi_{psh,y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 1.22434$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00154581$$

$$sh_1 = 0.00494661$$

$$ft_1 = 480.4475$$

$$fy_1 = 400.3729$$

$$su_1 = 0.00695956$$

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

and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00  
 $l_o/l_{ou,min} = l_b/l_d = 0.34790516$   
 $su_1 = 0.4 * esu_{1,nominal} ((5.5), TBDY) = 0.032$   
From table 5A.1, TBDY:  $esu_{1,nominal} = 0.08$ ,  
For calculation of  $esu_{1,nominal}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered  
characteristic value  $fsy_1 = fs_1/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
with  $fs_1 = (fs_{jacket} * Asl_{ten,jacket} + fs_{core} * Asl_{ten,core}) / Asl_{ten} = 400.3729$   
with  $Es_1 = (Es_{jacket} * Asl_{ten,jacket} + Es_{core} * Asl_{ten,core}) / Asl_{ten} = 200000.00$   
 $y_2 = 0.00154581$   
 $sh_2 = 0.00494661$   
 $ft_2 = 480.4475$   
 $fy_2 = 400.3729$   
 $su_2 = 0.00695956$   
using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00  
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.34790516$   
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$   
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  $fs_2 = (fs_{jacket} * Asl_{com,jacket} + fs_{core} * Asl_{com,core}) / Asl_{com} = 400.3729$   
with  $Es_2 = (Es_{jacket} * Asl_{com,jacket} + Es_{core} * Asl_{com,core}) / Asl_{com} = 200000.00$   
 $y_v = 0.00154581$   
 $sh_v = 0.00494661$   
 $ft_v = 486.7441$   
 $fy_v = 405.62$   
 $suv = 0.00695956$   
using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00  
 $l_o/l_{ou,min} = l_b/l_d = 0.34790516$   
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$   
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  $fsv = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 405.62$   
with  $Esv = (Es_{jacket} * Asl_{mid,jacket} + Es_{mid} * Asl_{mid,core}) / Asl_{mid} = 200000.00$   
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.04621209$   
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.04621209$   
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.02857496$   
and confined core properties:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.05541419$   
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.05541419$   
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.03426502$   
Case/Assumption: Unconfined full section - Steel rupture  
'satisfies Eq. (4.3)  
--->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is satisfied  
--->  
 $su (4.9) = 0.14932546$   
 $Mu = MRc (4.14) = 1.6654E+008$   
 $u = su (4.1) = 2.2916591E-005$

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

Lap Length:  $l_b/l_d = 0.34790516$

$l_b = 300.00$

$l_d = 862.304$

Calculation of  $l_b$ , min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$= 1$

$db = 15.23077$

Mean strength value of all re-bars:  $f_y = 645.3439$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of  $\mu_2$ -

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

$\mu = 2.2916591E-005$

$\mu_u = 1.6654E+008$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.0002896$

$N = 2285.866$

$f_c = 33.00$

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

Final value of  $\mu_u$ :  $\mu_u^* = \text{shear\_factor} * \text{Max}(\mu_u, \mu_c) = 0.00512221$

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

From (5.4b), TBDY:  $\mu_u = 0.00512221$

$\mu_{ue}$  (5.4c) = 0.00164473

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

$a_{se1} = 0.14776895$

$b_{o1} = 340.00$

$h_{o1} = 610.00$

$b_{i21} = 975400.00$

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

$b_{o2} = 192.00$

$h_{o2} = 492.00$

$b_{i22} = 557856.00$

$\mu_{sh,min} * F_{ywe} = \text{Min}(\mu_{sh,x} * F_{ywe}, \mu_{sh,y} * F_{ywe}) = 1.22434$

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)

$\mu_{sh,x} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 2.16539$

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

$A_{sh1} = A_{stir1} * n_{s1} = 157.0796$

No stirrups,  $n_{s1} = 2.00$

$h_1 = 670.00$

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

$A_{sh2} = A_{stir2} * n_{s2} = 100.531$

No stirrups,  $n_{s2} = 2.00$

$h_2 = 500.00$

$\mu_{sh,y} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 1.22434$

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

$A_{sh1} = A_{stir1} * n_{s1} = 157.0796$

No stirrups,  $n_{s1} = 2.00$

$h_1 = 400.00$

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

$A_{sh2} = A_{stir2} * n_{s2} = 100.531$

No stirrups, ns\_2 = 2.00  
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 555.55

fce = 33.00

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

c = confinement factor = 1.00

y1 = 0.00154581

sh1 = 0.00494661

ft1 = 480.4475

fy1 = 400.3729

su1 = 0.00695956

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

lo/lou,min = lb/ld = 0.34790516

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 = 400.3729

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

y2 = 0.00154581

sh2 = 0.00494661

ft2 = 480.4475

fy2 = 400.3729

su2 = 0.00695956

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

lo/lou,min = lb/lb,min = 0.34790516

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 = 400.3729

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

yv = 0.00154581

shv = 0.00494661

ftv = 486.7441

fyv = 405.62

suv = 0.00695956

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

lo/lou,min = lb/ld = 0.34790516

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 = 405.62

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

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.04621209

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.04621209

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.02857496

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00



$f_{cc}$  (5A.2, TBDY) = 33.00  
 $c_c$  (5A.5, TBDY) = 0.002  
 $c$  = confinement factor = 1.00  
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.05541419$   
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.05541419$   
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.03426502$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is satisfied  
 --->  
 $s_u$  (4.9) = 0.14932546  
 $\mu_u = M_{Rc}$  (4.14) = 1.6654E+008  
 $u = s_u$  (4.1) = 2.2916591E-005

Calculation of ratio  $l_b/l_d$

Lap Length:  $l_b/l_d = 0.34790516$   
 $l_b = 300.00$   
 $l_d = 862.304$   
 Calculation of  $l_b$ ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.  
 $= 1$   
 $db = 15.23077$   
 Mean strength value of all re-bars:  $f_y = 645.3439$   
 $t = 1.16154$   
 $s = 0.80$   
 $e = 1.00$   
 $cb = 25.00$   
 $K_{tr} = 2.64216$   
 $n = 13.00$

Calculation of Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 368172.80$

Calculation of Shear Strength at edge 1,  $V_{r1} = 368172.80$   
 $V_{r1} = V_n$  ((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:  $V_c = 182002.857$   
 $= 1$  (normal-weight concrete)  
 Mean concrete strength:  $f'_c = (f'_{c,jacket} \cdot \text{Area}_{jacket} + f'_{c,core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 28.14925$ , but  $f_c^{0.5} < =$   
 8.3 MPa (22.5.3.1, ACI 318-14)  
 $p_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / \mu_u < 1 = 0.00$   
 $\mu_u = 6.4841010E-012$   
 $V_u = 4.8511603E-015$   
 From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$   
 $V_{s1} = 186169.943$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 0.00$  is calculated for jacket, with:  
 $d_2 = 160.00$   
 $A_v = 100530.965$   
 $f_y = 444.44$   
 $s = 300.00$   
 $V_{s2}$  is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

Vf ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440: Vs + Vf <= 755657.47

Calculation of Shear Strength at edge 2, Vr2 = 368172.80  
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 = 182002.857  
= 1 (normal-weight concrete)  
Mean concrete strength: fc' = (fc'\_jacket\*Area\_jacket + fc'\_core\*Area\_core)/Area\_section = 28.14925, but fc'^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)  
pw = As/(bw\*d) = 0.00331157  
As (tension reinf.) = 709.9999  
bw = 670.00  
d = 320.00  
Vu\*d/Mu < 1 = 0.00  
Mu = 8.0658469E-012  
Vu = 4.8511603E-015  
From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 186169.943  
Vs1 = 186169.943 is calculated for jacket, with:  
d = 320.00  
Av = 157079.633  
fy = 555.56  
s = 150.00  
Vs1 has been multiplied by 1 (s<d/2, according to ASCE 41-17,10.3.4)  
Vs2 = 0.00 is calculated for jacket, with:  
d = 160.00  
Av = 100530.965  
fy = 444.44  
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 <= 755657.47

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, = 0.90  
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.  
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17  
Consequently:  
Jacket  
New material of Primary Member: Concrete Strength, fc = fcm = 33.00  
New material of Primary Member: Steel Strength, fs = fsm = 555.56  
Concrete Elasticity, Ec = 26999.444  
Steel Elasticity, Es = 200000.00  
Existing Column  
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00  
Existing material of Primary Member: Steel Strength, fs = fsm = 444.44  
Concrete Elasticity, Ec = 21019.039  
Steel Elasticity, Es = 200000.00  
External Height, H = 670.00  
External Width, W = 400.00  
Internal Height, H = 500.00  
Internal Width, W = 200.00

Cover Thickness,  $c = 25.00$   
 Element Length,  $L = 3000.00$   
 Primary Member  
 Ribbed Bars  
 Ductile Steel  
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)  
 Longitudinal Bars With Ends Lapped Starting at the End Sections  
 Lap Length  $l_b = 300.00$   
 No FRP Wrapping

#### Stepwise Properties

Bending Moment,  $M = 5.6071E+006$   
 Shear Force,  $V_2 = 7.3183079E-015$   
 Shear Force,  $V_3 = 4084.196$   
 Axial Force,  $F = -7206.737$   
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
   -Tension:  $As_t = 709.9999$   
   -Compression:  $As_c = 1668.186$   
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $As_{t,ten} = 709.9999$   
   -Compression:  $As_{l,com} = 1266.062$   
   -Middle:  $As_{l,mid} = 402.1239$   
 Longitudinal External Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $As_{t,ten,jacket} = 402.1239$   
   -Compression:  $As_{l,com,jacket} = 804.2477$   
   -Middle:  $As_{l,mid,jacket} = 402.1239$   
 Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $As_{t,ten,core} = 307.8761$   
   -Compression:  $As_{l,com,core} = 461.8141$   
   -Middle:  $As_{l,mid,core} = 0.00$   
 Mean Diameter of Tension Reinforcement,  $Db_L = 15.00$

Existing component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u_R = u = 0.00998344$   
 $u = y + p = 0.01109271$

- Calculation of  $y$  -

$y = (M_y * L_s / 3) / E_{eff} = 0.00109271$  ((4.29), Biskinis Phd))  
 $M_y = 1.8488E+008$   
 $L_s = M/V$  (with  $L_s > 0.1 * L$  and  $L_s < 2 * L$ ) = 1372.871  
 From table 10.5, ASCE 41\_17:  $E_{eff} = 0.3 * E_c * I_g = 7.7426E+013$

#### Calculation of Yielding Moment $M_y$

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

$y = \text{Min}(y_{ten}, y_{com})$   
 $y_{ten} = 3.6520086E-006$   
 with ((10.1), ASCE 41-17)  $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b / d)^{2/3}) = 372.8122$   
 $d = 627.00$   
 $y = 0.1859318$   
 $A = 0.00955948$   
 $B = 0.00411088$   
 with  $pt = 0.00283094$   
 $pc = 0.00504809$   
 $pv = 0.00160336$   
 $N = 7206.737$   
 $b = 400.00$   
 $" = 0.06858054$

y\_comp = 1.9022089E-005  
with fc = 28.14925  
Ec = 26999.444  
y = 0.18446156  
A = 0.00941709  
B = 0.0040338  
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.43488144

lb = 300.00

ld = 689.8432

Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

= 1

db = 15.23077

Mean strength value of all re-bars: fy = 516.2752

t = 1.16154

s = 0.80

e = 1.00

cb = 25.00

Ktr = 2.64216

n = 13.00

- Calculation of p -

From table 10-7: p = 0.01

with:

- Condition iv occurred

Beam controlled by inadequate embedment into beam-column joint:

(lb/ld < 1 and With Lapping in the Vicinity of the End Regions

- Condition i occurred

Beam controlled by flexure: Vp/Vo <= 1

shear control ratio Vp/Vo = 0.49656722

- Transverse Reinforcement: C

- Stirrup Spacing <= d/3

- Low ductility demand, / y < 2 (table 10-6, ASCE 41-17)

= 5.9796453E-005

- Stirrup Spacing <= d/2

d = d\_external = 627.00

s = s\_external = 150.00

- Strength provided by hoops Vs < 3/4\*design Shear

Vs = 371407.964, already given in calculation of shear control ratio

design Shear = 4084.196

- ( - ')/ bal = -0.26284228

= 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 = 0.0145354

fc = (fc\_jacket\*Area\_jacket+ fc\_core\*Area\_core)/section\_area = 28.14925

fy = fy\_jacket\_bars = 555.56

From 10.2.7.3, ACI 318-11: 1 = 0.65

From fig R10.3.3, ACI 318-11 (Ence 454, too): 87000/(87000+ fy) = cb/dt = 0.003/(0.003+ y) = 0.51922877

y = 0.0027778

- V/(bw\*d\*fc^0.5) = 0.03696314, NOTE: units in lb & in

bw = 400.00

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

At local axis: 2

Integration Section: (a)

## Calculation No. 3

beam B1, Floor 1

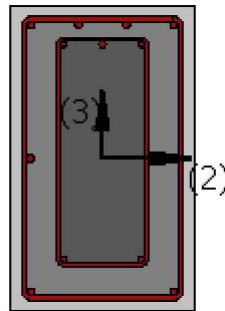
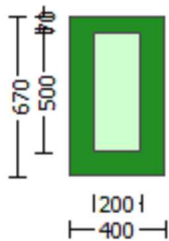
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity  $V_{Rd}$

Edge: Start

Local Axis: (3)



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

At local axis: 3

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 0.90$

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

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

Existing material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 16.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 400.00$

Concrete Elasticity,  $E_c = 21019.039$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars  
Ductile Steel  
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)  
Longitudinal Bars With Ends Lapped Starting at the End Sections  
Lap Length  $l_o = l_b = 300.00$   
No FRP Wrapping

#### Stepwise Properties

EDGE -A-  
Bending Moment,  $M_a = 5.6071E+006$   
Shear Force,  $V_a = 4084.196$   
EDGE -B-  
Bending Moment,  $M_b = 1.1663E+007$   
Shear Force,  $V_b = 15597.07$   
BOTH EDGES  
Axial Force,  $F = -7206.737$   
Longitudinal Reinforcement Area Distribution (in 2 divisions)  
-Tension:  $A_{sl} = 709.9999$   
-Compression:  $A_{slc} = 1668.186$   
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $A_{sl,ten} = 709.9999$   
-Compression:  $A_{sl,com} = 1266.062$   
-Middle:  $A_{sl,mid} = 402.1239$   
Mean Diameter of Tension Reinforcement,  $Db_{L,ten} = 15.00$

Existing component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $V_R = V_n = 424578.909$   
 $V_n$  ((22.5.1.1), ACI 318-14) = 471754.343

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:  $V_c = 164297.142$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_c_{jacket} \cdot Area_{jacket} + f'_c_{core} \cdot Area_{core}) / Area_{section} = 21.64179$ , 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  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / M_u < 1 = 0.39042262$   
 $M_u = 5.6071E+006$   
 $V_u = 4084.196$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 307457.201$   
 $V_{s1} = 280648.944$  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)  
 $V_{s2} = 26808.257$  is calculated for core, with:  
 $d = 400.00$   
 $A_v = 100530.965$   
 $f_y = 400.00$   
 $s = 300.00$   
 $V_{s2}$  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:  $V_s + V_f \leq 662579.716$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1  
At local axis: 3  
Integration Section: (a)

## Calculation No. 4

beam B1, Floor 1

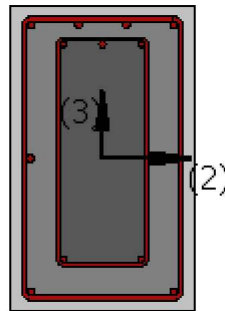
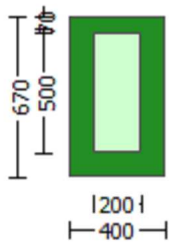
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (  $\theta$  )

Edge: Start

Local Axis: (3)



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

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\phi = 0.90$

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 20.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 444.44$

Concrete Elasticity,  $E_c = 21019.039$

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

Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 555.55$

#####

External Height, H = 670.00  
External Width, W = 400.00  
Internal Height, H = 500.00  
Internal Width, W = 200.00  
Cover Thickness, c = 25.00  
Mean Confinement Factor overall section = 1.00  
Element Length, L = 3000.00  
Primary Member  
Ribbed Bars  
Ductile Steel  
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)  
Longitudinal Bars With Ends Lapped Starting at the End Sections  
Lap Length  $l_o$  = 300.00  
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 = -2285.866  
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 ,  $V_e/V_r$  = 0.49656722  
Member Controlled by Flexure ( $V_e/V_r < 1$ )  
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u * l_n / 2 = 266008.163$   
with  
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 3.8425E+008$   
 $\mu_{u1+} = 2.2952E+008$ , 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  
 $\mu_{u1-} = 3.8425E+008$ , 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  
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 3.8425E+008$   
 $\mu_{u2+} = 2.2952E+008$ , 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  
 $\mu_{u2-} = 3.8425E+008$ , is the ultimate moment strength at the edge 2 of the member in the opposite moment  
direction which is defined for the the static loading combination  
and  
 $\pm w_u * l_n = (|V_1| + |V_2|)/2$   
with  
 $V_1 = 9840.632$ , 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  $\mu_{u1+}$

-----  
Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:  
 $\phi_u = 1.2638035E-005$   
 $\mu_u = 2.2952E+008$   
-----

with full section properties:



$b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027619$   
 $N = 2285.866$   
 $f_c = 33.00$   
 $\phi (5A.5, \text{TB DY}) = 0.002$   
 Final value of  $\phi$ :  $\phi^* = \text{shear\_factor} * \text{Max}(\phi, \phi_c) = 0.00512221$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TB DY:  $\phi = 0.00512221$   
 $\phi (5.4c) = 0.00164473$   
 $\phi (5.4d), \text{TB DY} = (\phi_1 * A_{ext} + \phi_2 * A_{int}) / A_{sec} = 0.14776895$   
 $\phi_1 = 0.14776895$   
 $b_o_1 = 340.00$   
 $h_o_1 = 610.00$   
 $b_{i2_1} = 975400.00$   
 $\phi_2 = \text{Max}(\phi_1, \phi_2) = 0.14776895$   
 $b_o_2 = 192.00$   
 $h_o_2 = 492.00$   
 $b_{i2_2} = 557856.00$   
 $\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.22434$   
 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)

---

$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.16539$   
 $\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 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,  $n_{s\_2} = 2.00$   
 $h_2 = 500.00$

---

$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.22434$   
 $\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 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,  $n_{s\_2} = 2.00$   
 $h_2 = 200.00$

---

$A_{sec} = 268000.00$   
 $s_1 = 150.00$   
 $s_2 = 300.00$   
 $f_{ywe1} = 694.45$   
 $f_{ywe2} = 555.55$   
 $f_{ce} = 33.00$   
 From ((5.A5), TB DY), TB DY:  $\phi_c = 0.002$   
 $\phi_c = \text{confinement factor} = 1.00$   
 $\phi_1 = 0.00154581$   
 $\phi_{sh1} = 0.00494661$   
 $\phi_{t1} = 470.5847$   
 $\phi_{y1} = 392.1539$   
 $\phi_{s1} = 0.00695956$

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

$\phi_o / \phi_{ou, \min} = \phi_b / \phi_d = 0.34790516$

$\phi_{s1} = 0.4 * \phi_{su1\_nominal} ((5.5), \text{TB DY}) = 0.032$

From table 5A.1, TB DY:  $\phi_{su1\_nominal} = 0.08$ ,

For calculation of  $\phi_{su1\_nominal}$  and  $\phi_1, \phi_{sh1}, \phi_{t1}, \phi_{y1}$ , it is considered  
 characteristic value  $\phi_{s1} = \phi_{s1} / 1.2$ , from table 5.1, TB DY.

$\phi_1, \phi_{sh1}, \phi_{t1}, \phi_{y1}$ , are also multiplied by  $\text{Min}(1, 1.25 * (\phi_b / \phi_d)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $\phi_{s1} = (\phi_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + \phi_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 392.1539$

```

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00154581
sh2 = 0.00494661
ft2 = 477.682
fy2 = 398.0683
su2 = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.34790516
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 = 398.0683
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00154581
shv = 0.00494661
ftv = 515.2755
fyv = 429.3962
suv = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.34790516
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 = 429.3962
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.03364135
2 = Asl,com/(b*d)*(fs2/fc) = 0.06089352
v = Asl,mid/(b*d)*(fsv/fc) = 0.02086299
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) = 0.0415669
2 = Asl,com/(b*d)*(fs2/fc) = 0.0752394
v = Asl,mid/(b*d)*(fsv/fc) = 0.0257781
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1217168
Mu = MRc (4.14) = 2.2952E+008
u = su (4.1) = 1.2638035E-005

```

#### Calculation of ratio lb/lb

```

Lap Length: lb/lb = 0.34790516
lb = 300.00
lb = 862.304
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 645.3439
t = 1.16154

```

s = 0.80  
e = 1.00  
cb = 25.00  
Ktr = 2.64216  
n = 13.00

Calculation of Mu1-

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

u = 1.3095001E-005  
Mu = 3.8425E+008

with full section properties:

b = 400.00  
d = 627.00  
d' = 43.00  
v = 0.00027619  
N = 2285.866  
fc = 33.00  
co (5A.5, TBDY) = 0.002  
Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.00512221$   
The Shear\_factor is considered equal to 1 (pure moment strength)  
From (5.4b), TBDY:  $\phi_u = 0.00512221$   
we (5.4c) = 0.00164473  
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

$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.22434$

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)

$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.16539$   
 $ps1$  (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

$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.22434$   
 $ps1$  (external) =  $(Ash1 * h1 / s1) / A_{sec} = 0.00156298$   
Ash1 = Astir\_1 \* ns\_1 = 157.0796  
No stirrups, ns\_1 = 2.00  
h1 = 400.00  
 $ps2$  (internal) =  $(Ash2 * h2 / s2) / A_{sec} = 0.00025008$   
Ash2 = Astir\_2 \* ns\_2 = 100.531  
No stirrups, ns\_2 = 2.00  
h2 = 200.00

Asec = 268000.00  
s1 = 150.00  
s2 = 300.00  
fywe1 = 694.45  
fywe2 = 555.55  
fce = 33.00

From ((5.A.5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $y1 = 0.00154581$   
 $sh1 = 0.00494661$   
 $ft1 = 477.682$   
 $fy1 = 398.0683$   
 $su1 = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou,min = lb/ld = 0.34790516$   
 $su1 = 0.4*esu1\_nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,  
 For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered  
 characteristic value  $fsy1 = fs1/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25*(lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 398.0683$   
 with  $Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$   
 $y2 = 0.00154581$   
 $sh2 = 0.00494661$   
 $ft2 = 470.5847$   
 $fy2 = 392.1539$   
 $su2 = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou,min = lb/lb,min = 0.34790516$   
 $su2 = 0.4*esu2\_nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esu2\_nominal = 0.08$ ,  
 For calculation of  $esu2\_nominal$  and  $y2, sh2, ft2, fy2$ , it is considered  
 characteristic value  $fsy2 = fs2/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25*(lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 392.1539$   
 with  $Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$   
 $yv = 0.00154581$   
 $shv = 0.00494661$   
 $ftv = 515.2755$   
 $fyv = 429.3962$   
 $suv = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou,min = lb/ld = 0.34790516$   
 $suv = 0.4*esuv\_nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv\_nominal = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv\_nominal$  and  $yv, shv, ftv, fyv$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25*(lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 429.3962$   
 with  $Es_v = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$   
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.06089352$   
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.03364135$   
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.02086299$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.0752394$   
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.0415669$   
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.0257781$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)

---

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

---->

$su(4.9) = 0.1523656$

$Mu = MRc(4.14) = 3.8425E+008$

$u = su(4.1) = 1.3095001E-005$

Calculation of ratio  $lb/ld$

Lap Length:  $lb/ld = 0.34790516$

$lb = 300.00$

$ld = 862.304$

Calculation of  $lb_{min}$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.  
 $= 1$

$db = 15.23077$

Mean strength value of all re-bars:  $f_y = 645.3439$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of  $Mu_{2+}$

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

$u = 1.2638035E-005$

$Mu = 2.2952E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.00027619$

$N = 2285.866$

$f_c = 33.00$

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

Final value of  $cu$ :  $cu^* = shear\_factor * Max(cu, cc) = 0.00512221$

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

From (5.4b), TBDY:  $cu = 0.00512221$

$w_e(5.4c) = 0.00164473$

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

$ase1 = 0.14776895$

$bo_1 = 340.00$

$ho_1 = 610.00$

$bi2_1 = 975400.00$

$ase2 = Max(ase1, ase2) = 0.14776895$

$bo_2 = 192.00$

$ho_2 = 492.00$

$bi2_2 = 557856.00$

$psh_{min} * F_{ywe} = Min(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.22434$

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)

$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.16539$

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

$Ash1 = Astir_1 * ns_1 = 157.0796$

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,  $ns_2 = 2.00$

$h2 = 500.00$

$psh\_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.22434$   
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00156298$   
 $Ash1 = Astir\_1 * ns\_1 = 157.0796$   
 $\text{No stirups, } ns\_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00025008$   
 $Ash2 = Astir\_2 * ns\_2 = 100.531$   
 $\text{No stirups, } ns\_2 = 2.00$   
 $h2 = 200.00$

$Asec = 268000.00$

$s1 = 150.00$

$s2 = 300.00$

$fywe1 = 694.45$

$fywe2 = 555.55$

$fce = 33.00$

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

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

$y1 = 0.00154581$

$sh1 = 0.00494661$

$ft1 = 470.5847$

$fy1 = 392.1539$

$su1 = 0.00695956$

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

$lo/lou, min = lb/ld = 0.34790516$

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

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  $fs1 = (fs\_jacket * Asl, ten, jacket + fs\_core * Asl, ten, core) / Asl, ten = 392.1539$

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

$y2 = 0.00154581$

$sh2 = 0.00494661$

$ft2 = 477.682$

$fy2 = 398.0683$

$su2 = 0.00695956$

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

$lo/lou, min = lb/lb, min = 0.34790516$

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

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  $fs2 = (fs\_jacket * Asl, com, jacket + fs\_core * Asl, com, core) / Asl, com = 398.0683$

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

$yv = 0.00154581$

$shv = 0.00494661$

$ftv = 515.2755$

$fyv = 429.3962$

$suv = 0.00695956$

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

$lo/lou, min = lb/ld = 0.34790516$

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

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

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

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

with  $fsv = (fs\_jacket * Asl, mid, jacket + fs\_mid * Asl, mid, core) / Asl, mid = 429.3962$

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

$$1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.03364135$$

$$2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.06089352$$

$$v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02086299$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

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

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

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

$$1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.0415669$$

$$2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.0752394$$

$$v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.0257781$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$su (4.9) = 0.1217168$$

$$\mu_u = M_{Rc} (4.14) = 2.2952E+008$$

$$u = su (4.1) = 1.2638035E-005$$

Calculation of ratio  $l_b/d$

Lap Length:  $l_b/d = 0.34790516$

$$l_b = 300.00$$

$$d = 862.304$$

Calculation of  $l_{b,min}$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars:  $f_y = 645.3439$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of  $\mu_u$

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

$$u = 1.3095001E-005$$

$$\mu_u = 3.8425E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027619$$

$$N = 2285.866$$

$$f_c = 33.00$$

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

$$\text{Final value of } cu: cu^* = \text{shear\_factor} \cdot \text{Max}(cu, cc) = 0.00512221$$

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

$$\text{From (5.4b), TBDY: } cu = 0.00512221$$

$$w_e (5.4c) = 0.00164473$$

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

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

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

$$bo\_2 = 192.00$$

$$ho\_2 = 492.00$$

$$bi2\_2 = 557856.00$$

$$psh\_min * Fywe = \text{Min}(psh\_x * Fywe, psh\_y * Fywe) = 1.22434$$

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)

$$psh\_x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 2.16539$$

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

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

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

$$h1 = 670.00$$

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

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

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

$$h2 = 500.00$$

$$psh\_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.22434$$

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

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

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

$$h1 = 400.00$$

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

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

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

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 555.55$$

$$fce = 33.00$$

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

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

$$y1 = 0.00154581$$

$$sh1 = 0.00494661$$

$$ft1 = 477.682$$

$$fy1 = 398.0683$$

$$su1 = 0.00695956$$

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

$$lo/lou, min = lb/l_d = 0.34790516$$

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

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

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

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

$$\text{with } fs1 = (fs\_jacket * Asl, ten, jacket + fs\_core * Asl, ten, core) / Asl, ten = 398.0683$$

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

$$y2 = 0.00154581$$

$$sh2 = 0.00494661$$

$$ft2 = 470.5847$$

$$fy2 = 392.1539$$

$$su2 = 0.00695956$$

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

$$lo/lou, min = lb/l_b, min = 0.34790516$$

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

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

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

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

$$\text{with } fs2 = (fs\_jacket * Asl, com, jacket + fs\_core * Asl, com, core) / Asl, com = 392.1539$$



$\text{with } Es_2 = (Es_{\text{jacket}} \cdot Asl_{\text{com,jacket}} + Es_{\text{core}} \cdot Asl_{\text{com,core}}) / Asl_{\text{com}} = 200000.00$   
 $y_v = 0.00154581$   
 $sh_v = 0.00494661$   
 $ft_v = 515.2755$   
 $fy_v = 429.3962$   
 $suv = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lo_{\text{min}} = lb/ld = 0.34790516$   
 $suv = 0.4 \cdot esuv_{\text{nominal}} ((5.5), \text{TBDY}) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{\text{nominal}} = 0.08$ ,  
 considering characteristic value  $fs_yv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{\text{nominal}}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fs_yv = fsv/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 $\text{with } fsv = (fs_{\text{jacket}} \cdot Asl_{\text{mid,jacket}} + fs_{\text{mid}} \cdot Asl_{\text{mid,core}}) / Asl_{\text{mid}} = 429.3962$   
 $\text{with } Es_v = (Es_{\text{jacket}} \cdot Asl_{\text{mid,jacket}} + Es_{\text{mid}} \cdot Asl_{\text{mid,core}}) / Asl_{\text{mid}} = 200000.00$   
 $1 = Asl_{\text{ten}} / (b \cdot d) \cdot (fs_1 / fc) = 0.06089352$   
 $2 = Asl_{\text{com}} / (b \cdot d) \cdot (fs_2 / fc) = 0.03364135$   
 $v = Asl_{\text{mid}} / (b \cdot d) \cdot (fsv / fc) = 0.02086299$

and confined core properties:

$b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $fcc (5A.2, \text{TBDY}) = 33.00$   
 $cc (5A.5, \text{TBDY}) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl_{\text{ten}} / (b \cdot d) \cdot (fs_1 / fc) = 0.0752394$   
 $2 = Asl_{\text{com}} / (b \cdot d) \cdot (fs_2 / fc) = 0.0415669$   
 $v = Asl_{\text{mid}} / (b \cdot d) \cdot (fsv / fc) = 0.0257781$

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

--->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.1523656$   
 $Mu = MRc (4.14) = 3.8425E+008$   
 $u = su (4.1) = 1.3095001E-005$

Calculation of ratio  $lb/ld$

Lap Length:  $lb/ld = 0.34790516$   
 $lb = 300.00$   
 $ld = 862.304$   
 Calculation of  $lb_{\text{min}}$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.  
 $= 1$   
 $db = 15.23077$   
 Mean strength value of all re-bars:  $fy = 645.3439$   
 $t = 1.16154$   
 $s = 0.80$   
 $e = 1.00$   
 $cb = 25.00$   
 $Ktr = 2.64216$   
 $n = 13.00$

Calculation of Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 535694.165$

Calculation of Shear Strength at edge 1,  $V_{r1} = 535694.165$   
 $V_{r1} = V_n ((22.5.1.1), \text{ACI 318-14})$

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

From Table (22.5.5.1), ACI 318-14:  $V_c = 194072.856$   
 $= 1$  (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot Area\_jacket + f'_{c\_core} \cdot Area\_core) / Area\_section = 28.14925$ , 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  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / M_u < 1 = 1.00$   
 $M_u = 1.1086E+006$   
 $V_u = 9840.632$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 341621.309$   
 $V_{s1} = 311834.654$  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)  
 $V_{s2} = 29786.655$  is calculated for jacket, with:  
 $d = 400.00$   
 $A_v = 100530.965$   
 $f_y = 444.44$   
 $s = 300.00$   
 $V_{s2}$  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:  $V_s + V_f \leq 755657.47$

Calculation of Shear Strength at edge 2,  $V_{r2} = 535694.165$   
 $V_{r2} = V_n$  ((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:  $V_c = 194072.856$   
 $= 1$  (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot Area\_jacket + f'_{c\_core} \cdot Area\_core) / Area\_section = 28.14925$ , 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  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / M_u < 1 = 1.00$   
 $M_u = 1.1086E+006$   
 $V_u = 9840.634$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 341621.309$   
 $V_{s1} = 311834.654$  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)  
 $V_{s2} = 29786.655$  is calculated for jacket, with:  
 $d = 400.00$   
 $A_v = 100530.965$   
 $f_y = 444.44$   
 $s = 300.00$   
 $V_{s2}$  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:  $V_s + V_f \leq 755657.47$

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,  $\phi = 0.90$

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 20.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 444.44$

Concrete Elasticity,  $E_c = 21019.039$

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

Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 555.55$

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length  $l_o = 300.00$

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force,  $V_a = 4.8511603E-015$

EDGE -B-

Shear Force,  $V_b = -4.8511603E-015$

BOTH EDGES

Axial Force,  $F = -2285.866$

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 ,  $V_e/V_r = 0.30156355$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 111027.496$   
with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 1.6654\text{E}+008$

$M_{u1+} = 1.6654\text{E}+008$ , 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

$M_{u1-} = 1.6654\text{E}+008$ , 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

$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 1.6654\text{E}+008$

$M_{u2+} = 1.6654\text{E}+008$ , 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

$M_{u2-} = 1.6654\text{E}+008$ , 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

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

with

$V_1 = 4.8511603\text{E}-015$ , is the shear force acting at edge 1 for the static loading combination

$V_2 = -4.8511603\text{E}-015$ , 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:

$\phi_u = 2.2916591\text{E}-005$

$M_u = 1.6654\text{E}+008$   
-----

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.0002896$

$N = 2285.866$

$f_c = 33.00$

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

Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00512221$

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

From (5.4b), TBDY:  $\phi_u = 0.00512221$

$\phi_{ue} (5.4c) = 0.00164473$

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

$\phi_{ase1} = 0.14776895$

$b_{o\_1} = 340.00$

$h_{o\_1} = 610.00$

$b_{i2\_1} = 975400.00$

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

$b_{o\_2} = 192.00$

$h_{o\_2} = 492.00$

$b_{i2\_2} = 557856.00$

$\phi_{psh,min} \cdot F_{ywe} = \text{Min}(\phi_{psh,x} \cdot F_{ywe}, \phi_{psh,y} \cdot F_{ywe}) = 1.22434$

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)

-----  
 $\phi_{psh,x} \cdot F_{ywe} = \phi_{psh1} \cdot F_{ywe1} + \phi_{psh2} \cdot F_{ywe2} = 2.16539$

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

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

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

$h_1 = 670.00$

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

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

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

$h_2 = 500.00$   
-----

$\phi_{psh,y} \cdot F_{ywe} = \phi_{psh1} \cdot F_{ywe1} + \phi_{psh2} \cdot F_{ywe2} = 1.22434$

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

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

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

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

$Asec = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$

$fywe1 = 694.45$   
 $fywe2 = 555.55$   
 $fce = 33.00$

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

$y1 = 0.00154581$   
 $sh1 = 0.00494661$

$ft1 = 480.4475$

$fy1 = 400.3729$

$su1 = 0.00695956$

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

$lo/lou,min = lb/ld = 0.34790516$

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

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  $fs1 = (fs,jacket \cdot Asl,ten,jacket + fs,core \cdot Asl,ten,core) / Asl,ten = 400.3729$

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

$y2 = 0.00154581$

$sh2 = 0.00494661$

$ft2 = 480.4475$

$fy2 = 400.3729$

$su2 = 0.00695956$

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

$lo/lou,min = lb/lb,min = 0.34790516$

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

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  $fs2 = (fs,jacket \cdot Asl,com,jacket + fs,core \cdot Asl,com,core) / Asl,com = 400.3729$

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

$yv = 0.00154581$

$shv = 0.00494661$

$ftv = 486.7441$

$fyv = 405.62$

$suv = 0.00695956$

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

$lo/lou,min = lb/ld = 0.34790516$

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

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  $fsv = (fs,jacket \cdot Asl,mid,jacket + fs,mid \cdot Asl,mid,core) / Asl,mid = 405.62$

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

$1 = Asl,ten / (b \cdot d) \cdot (fs1 / fc) = 0.04621209$

$2 = Asl,com / (b \cdot d) \cdot (fs2 / fc) = 0.04621209$

$v = Asl,mid / (b \cdot d) \cdot (fsv / fc) = 0.02857496$

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) = 0.05541419
2 = Asl,com/(b*d)*(fs2/fc) = 0.05541419
v = Asl,mid/(b*d)*(fsv/fc) = 0.03426502
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

```

```

--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.14932546
Mu = MRc (4.14) = 1.6654E+008
u = su (4.1) = 2.2916591E-005

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.34790516
lb = 300.00
ld = 862.304
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 645.3439
t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

```

Calculation of Mu1-

```

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 2.2916591E-005
Mu = 1.6654E+008

```

with full section properties:

```

b = 670.00
d = 357.00
d' = 43.00
v = 0.0002896
N = 2285.866
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00512221
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00512221
we (5.4c) = 0.00164473
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) = 1.22434

```

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)

$psh_x \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 2.16539$   
 $ps1$  (external) =  $(Ash1 \cdot h1 / s1) / A_{sec} = 0.00261799$   
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$   
No stirrups,  $ns_1 = 2.00$   
 $h1 = 670.00$   
 $ps2$  (internal) =  $(Ash2 \cdot h2 / s2) / A_{sec} = 0.00062519$   
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$   
No stirrups,  $ns_2 = 2.00$   
 $h2 = 500.00$

$psh_y \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 1.22434$   
 $ps1$  (external) =  $(Ash1 \cdot h1 / s1) / A_{sec} = 0.00156298$   
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$   
No stirrups,  $ns_1 = 2.00$   
 $h1 = 400.00$   
 $ps2$  (internal) =  $(Ash2 \cdot h2 / s2) / A_{sec} = 0.00025008$   
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$   
No stirrups,  $ns_2 = 2.00$   
 $h2 = 200.00$

$A_{sec} = 268000.00$

$s1 = 150.00$

$s2 = 300.00$

$fy_{we1} = 694.45$

$fy_{we2} = 555.55$

$f_{ce} = 33.00$

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

$c$  = confinement factor = 1.00

$y1 = 0.00154581$

$sh1 = 0.00494661$

$ft1 = 480.4475$

$fy1 = 400.3729$

$su1 = 0.00695956$

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

$lo/lo_{u,min} = lb/l_d = 0.34790516$

$su1 = 0.4 \cdot esu1_{nominal}$  ((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  $\text{Min}(1, 1.25 \cdot (lb/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs1 = (fs_{jacket} \cdot Asl_{ten,jacket} + fs_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 400.3729$

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

$y2 = 0.00154581$

$sh2 = 0.00494661$

$ft2 = 480.4475$

$fy2 = 400.3729$

$su2 = 0.00695956$

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

$lo/lo_{u,min} = lb/l_{b,min} = 0.34790516$

$su2 = 0.4 \cdot esu2_{nominal}$  ((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  $\text{Min}(1, 1.25 \cdot (lb/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 400.3729$

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

$y_v = 0.00154581$

$sh_v = 0.00494661$

$ft_v = 486.7441$

$fy_v = 405.62$

```

suv = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lo,min = lb/ld = 0.34790516
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 = 405.62
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04621209
2 = Asl,com/(b*d)*(fs2/fc) = 0.04621209
v = Asl,mid/(b*d)*(fsv/fc) = 0.02857496
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) = 0.05541419
2 = Asl,com/(b*d)*(fs2/fc) = 0.05541419
v = Asl,mid/(b*d)*(fsv/fc) = 0.03426502
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.14932546
Mu = MRc (4.14) = 1.6654E+008
u = su (4.1) = 2.2916591E-005
-----

Calculation of ratio lb/ld
-----
Lap Length: lb/ld = 0.34790516
lb = 300.00
ld = 862.304
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 645.3439
t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00
-----

Calculation of Mu2+
-----

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 2.2916591E-005
Mu = 1.6654E+008
-----
with full section properties:
b = 670.00
d = 357.00
d' = 43.00
v = 0.0002896

```



$N = 2285.866$   
 $f_c = 33.00$   
 $\alpha (5A.5, TBDY) = 0.002$   
 Final value of  $\alpha$ :  $\alpha^* = \text{shear\_factor} * \text{Max}(\alpha, \alpha_c) = 0.00512221$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $\alpha = 0.00512221$   
 $w_e (5.4c) = 0.00164473$   
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$   
 $a_{se1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.22434$   
 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)

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.16539$   
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 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,  $n_{s\_2} = 2.00$   
 $h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.22434$   
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 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,  $n_{s\_2} = 2.00$   
 $h_2 = 200.00$

$A_{sec} = 268000.00$   
 $s_1 = 150.00$   
 $s_2 = 300.00$   
 $f_{ywe1} = 694.45$   
 $f_{ywe2} = 555.55$   
 $f_{ce} = 33.00$

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

$y_1 = 0.00154581$   
 $sh_1 = 0.00494661$   
 $ft_1 = 480.4475$   
 $fy_1 = 400.3729$   
 $su_1 = 0.00695956$

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

$l_o / l_{ou, \min} = l_b / l_d = 0.34790516$

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

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

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

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

with  $fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 400.3729$

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

$y_2 = 0.00154581$   
 $sh_2 = 0.00494661$   
 $ft_2 = 480.4475$

```

fy2 = 400.3729
su2 = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.34790516
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 = 400.3729
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00154581
shv = 0.00494661
ftv = 486.7441
fyv = 405.62
suv = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.34790516
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 = 405.62
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04621209
2 = Asl,com/(b*d)*(fs2/fc) = 0.04621209
v = Asl,mid/(b*d)*(fsv/fc) = 0.02857496
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) = 0.05541419
2 = Asl,com/(b*d)*(fs2/fc) = 0.05541419
v = Asl,mid/(b*d)*(fsv/fc) = 0.03426502
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.14932546
Mu = MRc (4.14) = 1.6654E+008
u = su (4.1) = 2.2916591E-005

```

#### Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.34790516
lb = 300.00
ld = 862.304
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 645.3439
t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216

```

$$n = 13.00$$

Calculation of Mu2-

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

$$\mu = 2.2916591E-005$$

$$Mu = 1.6654E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0002896$$

$$N = 2285.866$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear\_factor} * \text{Max}(\mu, cc) = 0.00512221$$

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

$$\text{From (5.4b), TBDY: } \mu = 0.00512221$$

$$\mu_e \text{ (5.4c)} = 0.00164473$$

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

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

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

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

$$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.22434$$

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)

$$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.16539$$

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

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

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

$$h1 = 670.00$$

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

$$Ash2 = Astir_2 * ns_2 = 100.531$$

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

$$h2 = 500.00$$

$$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.22434$$

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

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

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

$$h1 = 400.00$$

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

$$Ash2 = Astir_2 * ns_2 = 100.531$$

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

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 555.55$$

$$f_{ce} = 33.00$$

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

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

$$y1 = 0.00154581$$

$$sh1 = 0.00494661$$

```

ft1 = 480.4475
fy1 = 400.3729
su1 = 0.00695956
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 0.34790516
    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 = 400.3729
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00154581
sh2 = 0.00494661
ft2 = 480.4475
fy2 = 400.3729
su2 = 0.00695956
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.34790516
    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 = 400.3729
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00154581
shv = 0.00494661
ftv = 486.7441
fyv = 405.62
suv = 0.00695956
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 0.34790516
    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 = 405.62
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04621209
2 = Asl,com/(b*d)*(fs2/fc) = 0.04621209
v = Asl,mid/(b*d)*(fsv/fc) = 0.02857496
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) = 0.05541419
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05541419
    v = Asl,mid/(b*d)*(fsv/fc) = 0.03426502
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.14932546
Mu = MRc (4.14) = 1.6654E+008

```

$$u = s_u(4.1) = 2.2916591E-005$$

Calculation of ratio  $l_b/d$

Lap Length:  $l_b/d = 0.34790516$

$$l_b = 300.00$$

$$l_d = 862.304$$

Calculation of  $l_b$ , min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars:  $f_y = 645.3439$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 368172.80$

Calculation of Shear Strength at edge 1,  $V_{r1} = 368172.80$

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

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

From Table (22.5.5.1), ACI 318-14:  $V_c = 182002.857$

= 1 (normal-weight concrete)

Mean concrete strength:  $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.14925$ , but  $f'_c^{0.5} \leq 8.3 \text{ MPa}$  (22.5.3.1, ACI 318-14)

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

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

$$b_w = 670.00$$

$$d = 320.00$$

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

$$\mu_u = 6.4841010E-012$$

$$V_u = 4.8511603E-015$$

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

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

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

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

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

$$d_2 = 160.00$$

$$A_v = 100530.965$$

$$f_y = 444.44$$

$$s = 300.00$$

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

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

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 755657.47$$

Calculation of Shear Strength at edge 2,  $V_{r2} = 368172.80$

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

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

From Table (22.5.5.1), ACI 318-14:  $V_c = 182002.857$

= 1 (normal-weight concrete)

Mean concrete strength:  $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.14925$ , but  $f'_c^{0.5} \leq 8.3 \text{ MPa}$  (22.5.3.1, ACI 318-14)

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

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

$b_w = 670.00$

$d = 320.00$

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

$M_u = 8.0658469E-012$

$V_u = 4.8511603E-015$

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

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

$d = 320.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 150.00$

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

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

$d = 160.00$

$A_v = 100530.965$

$f_y = 444.44$

$s = 300.00$

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

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

From (11-11), ACI 440:  $V_s + V_f \leq 755657.47$

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,  $\gamma = 0.90$

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

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 20.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 444.44$

Concrete Elasticity,  $E_c = 21019.039$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length  $l_b = 300.00$

No FRP Wrapping

Stepwise Properties

Bending Moment,  $M = -1.7152371\text{E-}011$   
 Shear Force,  $V2 = 7.3183079\text{E-}015$   
 Shear Force,  $V3 = 4084.196$   
 Axial Force,  $F = -7206.737$   
 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,  $Db_L = 15.20$

Existing component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $\phi_R = \phi_u = 0.00689938$   
 $\phi_u = \phi_y + \phi_p = 0.00766598$

- Calculation of  $\phi_y$  -

$\phi_y = (M_y \cdot L_s / 3) / E_{eff} = 0.00266598$  ((4.29), Biskinis Phd))  
 $M_y = 1.3440\text{E+}008$   
 $L_s = M/V$  (with  $L_s > 0.1 \cdot L$  and  $L_s < 2 \cdot L$ ) = 1500.00  
 From table 10.5, ASCE 41\_17:  $E_{eff} = 0.3 \cdot E_c \cdot I_g = 2.5206\text{E+}013$

Calculation of Yielding Moment  $M_y$

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

$\phi_y = \text{Min}(\phi_{y,ten}, \phi_{y,com})$   
 $\phi_{y,ten} = 6.7327472\text{E-}006$   
 with ((10.1), ASCE 41-17)  $\phi_y = \text{Min}(\phi_y, 1.25 \cdot \phi_y \cdot (I_b / I_d)^{2/3}) = 372.8122$   
 $d = 357.00$   
 $\phi_y = 0.22446823$   
 $A = 0.01002348$   
 $B = 0.00565094$   
 with  $p_t = 0.00380895$   
 $p_c = 0.00380895$   
 $p_v = 0.00232477$   
 $N = 7206.737$   
 $b = 670.00$   
 $\phi_y = 0.12044818$   
 $\phi_{y,comp} = 2.7599242\text{E-}005$   
 with  $f_c = 28.14925$   
 $E_c = 26999.444$   
 $\phi_y = 0.22328844$   
 $A = 0.00987419$   
 $B = 0.00557012$   
 with  $E_s = 200000.00$

Calculation of ratio  $I_b / I_d$

Lap Length:  $I_d / I_{d,min} = 0.43488144$

$$l_b = 300.00$$

$$l_d = 689.8432$$

Calculation of  $\lambda$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars:  $f_y = 516.2752$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

- Calculation of  $p$  -

From table 10-7:  $p = 0.005$

with:

- Condition iv occurred

Beam controlled by inadequate embedment into beam-column joint:  
( $l_b/l_d < 1$  and With Lapping in the Vicinity of the End Regions)

- Condition i occurred

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

shear control ratio  $V_p/V_o = 0.30156355$

- Transverse Reinforcement: NC

- Stirrup Spacing  $> d/3$

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

$$= 3.1168017E-023$$

- Stirrup Spacing  $\leq d/2$

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

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

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

$V_s = 209999.267$ , already given in calculation of shear control ratio

design Shear =  $7.3183079E-015$

- ( $\lambda$  -  $y$ )/  $\text{bal} = -0.27560034$

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

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

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

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

From (B-1), ACI 318-11:  $\text{bal} = 0.0145354$

$$f_c = (f_{c\_jacket} \cdot \text{Area}_{jacket} + f_{c\_core} \cdot \text{Area}_{core}) / \text{section\_area} = 28.14925$$

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

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

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

$$y = 0.0027778$$

-  $V/(b_w \cdot d \cdot f_c^{0.5}) = 6.9447633E-020$ , 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

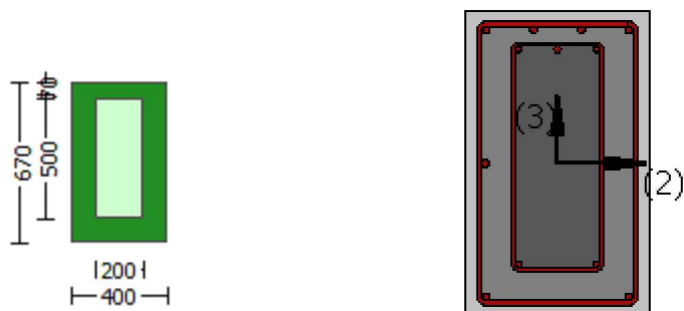
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

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,  $\gamma = 0.90$

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

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

Existing material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 16.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 400.00$

Concrete Elasticity,  $E_c = 21019.039$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length  $l_o = l_b = 300.00$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment,  $M_a = -1.7152371\text{E-}011$   
 Shear Force,  $V_a = 7.3183079\text{E-}015$   
 EDGE -B-  
 Bending Moment,  $M_b = 3.8904059\text{E-}011$   
 Shear Force,  $V_b = -7.3183079\text{E-}015$   
 BOTH EDGES  
 Axial Force,  $F = -7206.737$   
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
   -Tension:  $A_{st} = 709.9999$   
   -Compression:  $A_{sc} = 1668.186$   
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $A_{st,ten} = 911.0619$   
   -Compression:  $A_{sc,com} = 911.0619$   
   -Middle:  $A_{st,mid} = 556.0619$   
 Mean Diameter of Tension Reinforcement,  $Db_{L,ten} = 15.20$

Existing component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $V_R = \phi V_n = 294422.714$   
 $V_n ((22.5.1.1), \text{ACI } 318-14) = 327136.349$

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

From Table (22.5.5.1), ACI 318-14:  $V_c = 159584.741$   
   = 1 (normal-weight concrete)  
 Mean concrete strength:  $f'_c = (f'_{c,jacket} \cdot \text{Area}_{jacket} + f'_{c,core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 21.64179$ , but  $f'_c^{0.5} \leq 8.3 \text{ MPa}$  (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 3.8904059\text{E-}011$   
 $V_u = 7.3183079\text{E-}015$   
 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:  
 $d = 160.00$   
 $A_v = 100530.965$   
 $f_y = 400.00$   
 $s = 300.00$   
 $V_{s2}$  is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)  
 $V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$   
 From (11-11), ACI 440:  $V_s + V_f \leq 662579.716$

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

beam B1, Floor 1

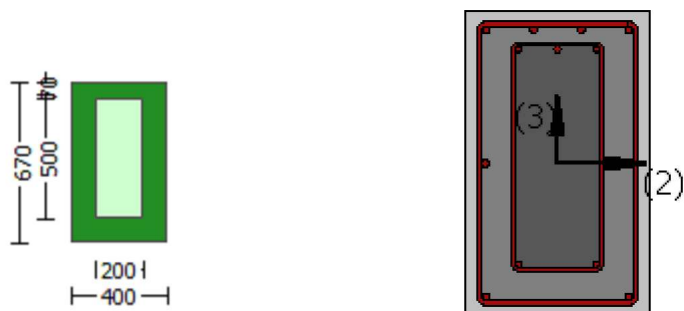
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity ( $\phi$ )

Edge: End

Local Axis: (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,  $\gamma = 0.90$

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 20.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 444.44$

Concrete Elasticity,  $E_c = 21019.039$

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

Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 555.55$

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections  
Lap Length  $l_o = 300.00$   
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,  $F = -2285.866$   
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,  $V_e/V_r = 0.49656722$   
Member Controlled by Flexure ( $V_e/V_r < 1$ )  
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 266008.163$   
with  
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 3.8425E+008$   
 $Mu_{1+} = 2.2952E+008$ , 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  
 $Mu_{1-} = 3.8425E+008$ , 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  
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 3.8425E+008$   
 $Mu_{2+} = 2.2952E+008$ , 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  
 $Mu_{2-} = 3.8425E+008$ , 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:  
 $\phi_u = 1.2638035E-005$   
 $M_u = 2.2952E+008$

with full section properties:

$b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027619$   
 $N = 2285.866$   
 $f_c = 33.00$   
 $\phi_o$  (5A.5, TBDY) = 0.002  
Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} \cdot \text{Max}(\phi_u, \phi_o) = 0.00512221$   
The Shear\_factor is considered equal to 1 (pure moment strength)  
From (5.4b), TBDY:  $\phi_u = 0.00512221$   
we (5.4c) = 0.00164473  
 $\phi_{ase}$  ((5.4d), TBDY) =  $(\phi_{ase1} \cdot A_{ext} + \phi_{ase2} \cdot A_{int})/A_{sec} = 0.14776895$

```

ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.22434
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 = 2.16539
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 = 1.22434
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 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00154581
sh1 = 0.00494661
ft1 = 470.5847
fy1 = 392.1539
su1 = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.34790516
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 = 392.1539
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00154581
sh2 = 0.00494661
ft2 = 477.682
fy2 = 398.0683
su2 = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.34790516
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,

```

For calculation of  $es_{u2\_nominal}$  and  $y_2$ ,  $sh_2$ ,  $ft_2$ ,  $fy_2$ , it is considered characteristic value  $fs_{y2} = fs_2/1.2$ , from table 5.1, TBDY.

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

with  $fs_2 = (fs_{jacket} \cdot A_{sl,com,jacket} + fs_{core} \cdot A_{sl,com,core}) / A_{sl,com} = 398.0683$

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

$y_v = 0.00154581$

$sh_v = 0.00494661$

$ft_v = 515.2755$

$fy_v = 429.3962$

$suv = 0.00695956$

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

$l_o/l_{ou,min} = l_b/l_d = 0.34790516$

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

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

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

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

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

with  $fs_v = (fs_{jacket} \cdot A_{sl,mid,jacket} + fs_{mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 429.3962$

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

$1 = A_{sl,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.03364135$

$2 = A_{sl,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.06089352$

$v = A_{sl,mid} / (b \cdot d) \cdot (fs_v / fc) = 0.02086299$

and confined core properties:

$b = 340.00$

$d = 597.00$

$d' = 13.00$

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

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

$c$  = confinement factor = 1.00

$1 = A_{sl,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.0415669$

$2 = A_{sl,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.0752394$

$v = A_{sl,mid} / (b \cdot d) \cdot (fs_v / fc) = 0.0257781$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su$  (4.9) = 0.1217168

$Mu = MRc$  (4.14) = 2.2952E+008

$u = su$  (4.1) = 1.2638035E-005

-----

Calculation of ratio  $l_b/l_d$

-----

Lap Length:  $l_b/l_d = 0.34790516$

$l_b = 300.00$

$l_d = 862.304$

Calculation of  $l_{b,min}$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

= 1

$db = 15.23077$

Mean strength value of all re-bars:  $fy = 645.3439$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

-----

-----

Calculation of  $Mu_1$ -

-----

-----

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

$$\phi_u = 1.3095001E-005$$

$$\mu = 3.8425E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027619$$

$$N = 2285.866$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.00512221$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.00512221$$

$$\omega_e (5.4c) = 0.00164473$$

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

$$a_{se1} = 0.14776895$$

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

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

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

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

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

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

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

$$\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.22434$$

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)

$$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.16539$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.22434$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00154581$$

$$sh_1 = 0.00494661$$

$$f_{t1} = 477.682$$

$$f_{y1} = 398.0683$$

$$su_1 = 0.00695956$$

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

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

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

$$I_o / I_{ou, \min} = I_b / I_d = 0.34790516$$

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

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  $fs1 = (fs\_jacket \cdot Asl\_ten\_jacket + fs\_core \cdot Asl\_ten\_core) / Asl\_ten = 398.0683$   
with  $Es1 = (Es\_jacket \cdot Asl\_ten\_jacket + Es\_core \cdot Asl\_ten\_core) / Asl\_ten = 200000.00$   
 $y2 = 0.00154581$   
 $sh2 = 0.00494661$   
 $ft2 = 470.5847$   
 $fy2 = 392.1539$   
 $su2 = 0.00695956$   
using (30) in Biskinis/Fardis (2013) multiplied with  $shear\_factor$   
and also multiplied by the  $shear\_factor$  according to 15.7.1.4, with  
 $Shear\_factor = 1.00$   
 $lo/lou, min = lb/lb, min = 0.34790516$   
 $su2 = 0.4 \cdot esu2\_nominal ((5.5), TBDY) = 0.032$   
From table 5A.1, TBDY:  $esu2\_nominal = 0.08$ ,  
For calculation of  $esu2\_nominal$  and  $y2, sh2, ft2, fy2$ , it is considered  
characteristic value  $fsy2 = fs2/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
with  $fs2 = (fs\_jacket \cdot Asl\_com\_jacket + fs\_core \cdot Asl\_com\_core) / Asl\_com = 392.1539$   
with  $Es2 = (Es\_jacket \cdot Asl\_com\_jacket + Es\_core \cdot Asl\_com\_core) / Asl\_com = 200000.00$   
 $yv = 0.00154581$   
 $shv = 0.00494661$   
 $ftv = 515.2755$   
 $fyv = 429.3962$   
 $suv = 0.00695956$   
using (30) in Biskinis/Fardis (2013) multiplied with  $shear\_factor$   
and also multiplied by the  $shear\_factor$  according to 15.7.1.4, with  
 $Shear\_factor = 1.00$   
 $lo/lou, min = lb/ld = 0.34790516$   
 $suv = 0.4 \cdot esuv\_nominal ((5.5), TBDY) = 0.032$   
From table 5A.1, TBDY:  $esuv\_nominal = 0.08$ ,  
considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
For calculation of  $esuv\_nominal$  and  $yv, shv, ftv, fyv$ , it is considered  
characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
with  $fsv = (fs\_jacket \cdot Asl\_mid\_jacket + fs\_mid \cdot Asl\_mid\_core) / Asl\_mid = 429.3962$   
with  $Es_v = (Es\_jacket \cdot Asl\_mid\_jacket + Es\_mid \cdot Asl\_mid\_core) / Asl\_mid = 200000.00$   
 $1 = Asl\_ten / (b \cdot d) \cdot (fs1 / fc) = 0.06089352$   
 $2 = Asl\_com / (b \cdot d) \cdot (fs2 / fc) = 0.03364135$   
 $v = Asl\_mid / (b \cdot d) \cdot (fsv / fc) = 0.02086299$   
and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl\_ten / (b \cdot d) \cdot (fs1 / fc) = 0.0752394$   
 $2 = Asl\_com / (b \cdot d) \cdot (fs2 / fc) = 0.0415669$   
 $v = Asl\_mid / (b \cdot d) \cdot (fsv / fc) = 0.0257781$   
Case/Assumption: Unconfined full section - Steel rupture  
'satisfies Eq. (4.3)  
--->  
 $v < vs, y2$  - LHS eq.(4.5) is satisfied  
--->  
 $su (4.9) = 0.1523656$   
 $Mu = MRc (4.14) = 3.8425E+008$   
 $u = su (4.1) = 1.3095001E-005$

Calculation of ratio  $lb/ld$

Lap Length:  $lb/ld = 0.34790516$   
 $lb = 300.00$   
 $ld = 862.304$



Calculation of  $I_{b,min}$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars:  $f_y = 645.3439$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of  $\mu_{2+}$

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

$$\mu = 1.2638035E-005$$

$$\mu = 2.2952E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027619$$

$$N = 2285.866$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear\_factor} * \text{Max}(\mu, c_o) = 0.00512221$$

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

$$\text{From (5.4b), TBDY: } \mu = 0.00512221$$

$$w_e(5.4c) = 0.00164473$$

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

$$a_{se1} = 0.14776895$$

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

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

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

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

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

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

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

$$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.22434$$

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)

$$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.16539$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$p_{sh,y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.22434$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$s1 = 150.00$   
 $s2 = 300.00$   
 $fy_{we1} = 694.45$   
 $fy_{we2} = 555.55$   
 $f_{ce} = 33.00$   
 From ((5.A.5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $y1 = 0.00154581$   
 $sh1 = 0.00494661$   
 $ft1 = 470.5847$   
 $fy1 = 392.1539$   
 $su1 = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou, \min = lb/ld = 0.34790516$   
 $su1 = 0.4 * esu1\_nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,  
 For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered  
 characteristic value  $fsy1 = fs1/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 392.1539$   
 with  $Es1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$   
 $y2 = 0.00154581$   
 $sh2 = 0.00494661$   
 $ft2 = 477.682$   
 $fy2 = 398.0683$   
 $su2 = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou, \min = lb/lb, \min = 0.34790516$   
 $su2 = 0.4 * esu2\_nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esu2\_nominal = 0.08$ ,  
 For calculation of  $esu2\_nominal$  and  $y2, sh2, ft2, fy2$ , it is considered  
 characteristic value  $fsy2 = fs2/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 398.0683$   
 with  $Es2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$   
 $yv = 0.00154581$   
 $shv = 0.00494661$   
 $ftv = 515.2755$   
 $fyv = 429.3962$   
 $suv = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou, \min = lb/ld = 0.34790516$   
 $suv = 0.4 * esuv\_nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv\_nominal = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv\_nominal$  and  $yv, shv, ftv, fyv$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 429.3962$   
 with  $Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$   
 $1 = A_{sl,ten} / (b * d) * (fs1 / f_c) = 0.03364135$   
 $2 = A_{sl,com} / (b * d) * (fs2 / f_c) = 0.06089352$   
 $v = A_{sl,mid} / (b * d) * (fsv / f_c) = 0.02086299$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten} / (b * d) * (fs1 / f_c) = 0.0415669$

$$2 = A_{sl,com}/(b*d)*(f_s2/f_c) = 0.0752394$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.0257781$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

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

---->

$$s_u(4.9) = 0.1217168$$

$$M_u = M_{Rc}(4.14) = 2.2952E+008$$

$$u = s_u(4.1) = 1.2638035E-005$$

Calculation of ratio  $l_b/l_d$

Lap Length:  $l_b/l_d = 0.34790516$

$$l_b = 300.00$$

$$l_d = 862.304$$

Calculation of  $l_b, \min$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars:  $f_y = 645.3439$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of  $M_{u2}$ -

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

$$u = 1.3095001E-005$$

$$M_u = 3.8425E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027619$$

$$N = 2285.866$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_o) = 0.00512221$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.00512221$$

$$\phi_{we}(5.4c) = 0.00164473$$

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

$$a_{se1} = 0.14776895$$

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

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

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

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

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

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

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

$$\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.22434$$

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)

$$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.16539$$

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

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

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

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

$psh\_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.22434$   
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$   
 $Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$   
 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,  $ns\_2 = 2.00$   
 $h2 = 200.00$

$Asec = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fywe1 = 694.45$   
 $fywe2 = 555.55$   
 $fce = 33.00$

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

$y1 = 0.00154581$   
 $sh1 = 0.00494661$   
 $ft1 = 477.682$   
 $fy1 = 398.0683$   
 $su1 = 0.00695956$

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

$lo/lou, min = lb/ld = 0.34790516$

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

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  $fs1 = (fs\_jacket \cdot Asl, ten, jacket + fs\_core \cdot Asl, ten, core) / Asl, ten = 398.0683$

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

$y2 = 0.00154581$   
 $sh2 = 0.00494661$   
 $ft2 = 470.5847$   
 $fy2 = 392.1539$   
 $su2 = 0.00695956$

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

$lo/lou, min = lb/lb, min = 0.34790516$

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

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  $fs2 = (fs\_jacket \cdot Asl, com, jacket + fs\_core \cdot Asl, com, core) / Asl, com = 392.1539$

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

$yv = 0.00154581$   
 $shv = 0.00494661$   
 $ftv = 515.2755$   
 $fyv = 429.3962$   
 $suv = 0.00695956$

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

$lo/lou, min = lb/ld = 0.34790516$

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

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

considering characteristic value  $f_{sv} = f_{sv}/1.2$ , from table 5.1, TBDY  
For calculation of  $e_{suv\_nominal}$  and  $y_v$ ,  $sh_v$ ,  $ft_v$ ,  $f_{yv}$ , it is considered  
characteristic value  $f_{sv} = f_{sv}/1.2$ , from table 5.1, TBDY.

$y_1$ ,  $sh_1$ ,  $ft_1$ ,  $f_{y1}$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 429.3962$

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

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.06089352$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.03364135$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02086299$

and confined core properties:

$b = 340.00$

$d = 597.00$

$d' = 13.00$

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

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

$c$  = confinement factor = 1.00

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.0752394$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.0415669$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.0257781$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su$  (4.9) = 0.1523656

$Mu = MR_c$  (4.14) = 3.8425E+008

$u = su$  (4.1) = 1.3095001E-005

Calculation of ratio  $l_b/l_d$

Lap Length:  $l_b/l_d = 0.34790516$

$l_b = 300.00$

$l_d = 862.304$

Calculation of  $l_{b,min}$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

= 1

$db = 15.23077$

Mean strength value of all re-bars:  $f_y = 645.3439$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 535694.165$

Calculation of Shear Strength at edge 1,  $V_{r1} = 535694.165$

$V_{r1} = V_n$  ((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:  $V_c = 194072.856$

= 1 (normal-weight concrete)

Mean concrete strength:  $f'_c = (f'_{c,jacket} \cdot \text{Area}_{jacket} + f'_{c,core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 28.14925$ , but  $f_c^{0.5} <= 8.3$  MPa (22.5.3.1, ACI 318-14)

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

$A_s$  (tension reinf.) = 709.9999

$b_w = 400.00$

$d = 536.00$

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

$Mu = 1.1086E+006$

$V_u = 9840.632$

From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 341621.309$

$V_{s1} = 311834.654$  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)

$V_{s2} = 29786.655$  is calculated for jacket, with:

$$d_2 = 400.00$$

$$A_v = 100530.965$$

$$f_y = 444.44$$

$$s = 300.00$$

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

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

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

$$\text{From } (11-11), \text{ACI } 440: V_s + V_f \leq 755657.47$$

Calculation of Shear Strength at edge 2,  $V_{r2} = 535694.165$

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

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

From Table (22.5.5.1), ACI 318-14:  $V_c = 194072.856$

= 1 (normal-weight concrete)

Mean concrete strength:  $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.14925$ , but  $f'_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

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

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

$$b_w = 400.00$$

$$d = 536.00$$

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

$$M_u = 1.1086 \text{E}+006$$

$$V_u = 9840.634$$

From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 341621.309$

$V_{s1} = 311834.654$  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)

$V_{s2} = 29786.655$  is calculated for jacket, with:

$$d = 400.00$$

$$A_v = 100530.965$$

$$f_y = 444.44$$

$$s = 300.00$$

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

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

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

$$\text{From } (11-11), \text{ACI } 440: V_s + V_f \leq 755657.47$$

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, = 0.90

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

Consequently:

```

Jacket
New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$ 
New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$ 
Concrete Elasticity,  $E_c = 26999.444$ 
Steel Elasticity,  $E_s = 200000.00$ 
Existing Column
Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 20.00$ 
Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 444.44$ 
Concrete Elasticity,  $E_c = 21019.039$ 
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
Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 555.55$ 
#####
External Height,  $H = 670.00$ 
External Width,  $W = 400.00$ 
Internal Height,  $H = 500.00$ 
Internal Width,  $W = 200.00$ 
Cover Thickness,  $c = 25.00$ 
Mean Confinement Factor overall section = 1.00
Element Length,  $L = 3000.00$ 
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length  $l_o = 300.00$ 
No FRP Wrapping
-----

Stepwise Properties
-----
At local axis: 2
EDGE -A-
Shear Force,  $V_a = 4.8511603E-015$ 
EDGE -B-
Shear Force,  $V_b = -4.8511603E-015$ 
BOTH EDGES
Axial Force,  $F = -2285.866$ 
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension:  $A_{sl} = 709.9999$ 
-Compression:  $A_{sc} = 1668.186$ 
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension:  $A_{sl,ten} = 911.0619$ 
-Compression:  $A_{sl,com} = 911.0619$ 
-Middle:  $A_{sl,mid} = 556.0619$ 
-----
-----

Calculation of Shear Capacity ratio ,  $V_e/V_r = 0.30156355$ 
Member Controlled by Flexure ( $V_e/V_r < 1$ )
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 111027.496$ 
with
 $M_{pr1} = \text{Max}(Mu_{1+} , Mu_{1-}) = 1.6654E+008$ 
 $Mu_{1+} = 1.6654E+008$ , is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
 $Mu_{1-} = 1.6654E+008$ , is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(Mu_{2+} , Mu_{2-}) = 1.6654E+008$ 
 $Mu_{2+} = 1.6654E+008$ , 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
 $Mu_{2-} = 1.6654E+008$ , 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 = 4.8511603E-015, is the shear force acting at edge 1 for the the static loading combination

V2 = -4.8511603E-015, is the shear force acting at edge 2 for the the static loading combination

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

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

$$u = 2.2916591E-005$$

$$Mu = 1.6654E+008$$

-----  
with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0002896$$

$$N = 2285.866$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_{co}) = 0.00512221$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.00512221$$

$$\phi_{we} (5.4c) = 0.00164473$$

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

$$\phi_{ase1} = 0.14776895$$

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

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

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

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

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

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

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

$$\phi_{psh, \min} * F_{ywe} = \text{Min}(\phi_{psh, x} * F_{ywe}, \phi_{psh, y} * F_{ywe}) = 1.22434$$

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)

$$\phi_{psh, x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 2.16539$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$\phi_{psh, y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 1.22434$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$



From ((5A.5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $y1 = 0.00154581$   
 $sh1 = 0.00494661$   
 $ft1 = 480.4475$   
 $fy1 = 400.3729$   
 $su1 = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou,min = lb/ld = 0.34790516$   
 $su1 = 0.4*esu1\_nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,  
 For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered  
 characteristic value  $fsy1 = fs1/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25*(lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 400.3729$   
 with  $Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$   
 $y2 = 0.00154581$   
 $sh2 = 0.00494661$   
 $ft2 = 480.4475$   
 $fy2 = 400.3729$   
 $su2 = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou,min = lb/lb,min = 0.34790516$   
 $su2 = 0.4*esu2\_nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esu2\_nominal = 0.08$ ,  
 For calculation of  $esu2\_nominal$  and  $y2, sh2, ft2, fy2$ , it is considered  
 characteristic value  $fsy2 = fs2/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25*(lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 400.3729$   
 with  $Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$   
 $yv = 0.00154581$   
 $shv = 0.00494661$   
 $ftv = 486.7441$   
 $fyv = 405.62$   
 $suv = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou,min = lb/ld = 0.34790516$   
 $suv = 0.4*esuv\_nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv\_nominal = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv\_nominal$  and  $yv, shv, ftv, fyv$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25*(lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 405.62$   
 with  $Es_v = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$   
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.04621209$   
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.04621209$   
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.02857496$   
 and confined core properties:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.05541419$   
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.05541419$   
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.03426502$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)

---

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

---->

$\mu_u(4.9) = 0.14932546$

$\mu_u = M_{Rc}(4.14) = 1.6654E+008$

$u = \mu_u(4.1) = 2.2916591E-005$

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

-----  
Lap Length:  $l_b/l_d = 0.34790516$

$l_b = 300.00$

$l_d = 862.304$

Calculation of  $l_b, \min$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$= 1$

$d_b = 15.23077$

Mean strength value of all re-bars:  $f_y = 645.3439$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$c_b = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

-----  
Calculation of  $\mu_{u1}$ -

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

$u = 2.2916591E-005$

$\mu_u = 1.6654E+008$

-----  
with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.0002896$

$N = 2285.866$

$f_c = 33.00$

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

Final value of  $\phi_{cu}$ :  $\phi_{cu}^* = \text{shear\_factor} * \text{Max}(\phi_{cu}, \phi_c) = 0.00512221$

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

From (5.4b), TBDY:  $\phi_{cu} = 0.00512221$

$\phi_{we}(5.4c) = 0.00164473$

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

$\phi_{ase1} = 0.14776895$

$b_{o\_1} = 340.00$

$h_{o\_1} = 610.00$

$b_{i2\_1} = 975400.00$

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

$b_{o\_2} = 192.00$

$h_{o\_2} = 492.00$

$b_{i2\_2} = 557856.00$

$\phi_{psh, \min} * F_{ywe} = \text{Min}(\phi_{psh, x} * F_{ywe}, \phi_{psh, y} * F_{ywe}) = 1.22434$

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)

-----  
 $\phi_{psh, x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{ps2} * F_{ywe2} = 2.16539$

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

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

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,  $n_{s\_2} = 2.00$

$h_2 = 500.00$

$psh\_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.22434$   
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00156298$   
 $Ash1 = Astir\_1 * ns\_1 = 157.0796$   
 $\text{No stirups, } ns\_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00025008$   
 $Ash2 = Astir\_2 * ns\_2 = 100.531$   
 $\text{No stirups, } ns\_2 = 2.00$   
 $h2 = 200.00$

$Asec = 268000.00$

$s1 = 150.00$

$s2 = 300.00$

$fywe1 = 694.45$

$fywe2 = 555.55$

$fce = 33.00$

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

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

$y1 = 0.00154581$

$sh1 = 0.00494661$

$ft1 = 480.4475$

$fy1 = 400.3729$

$su1 = 0.00695956$

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

$lo/lou, min = lb/ld = 0.34790516$

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

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  $fs1 = (fs\_jacket * Asl, ten, jacket + fs\_core * Asl, ten, core) / Asl, ten = 400.3729$

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

$y2 = 0.00154581$

$sh2 = 0.00494661$

$ft2 = 480.4475$

$fy2 = 400.3729$

$su2 = 0.00695956$

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

$lo/lou, min = lb/lb, min = 0.34790516$

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

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

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

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

with  $fs2 = (fs\_jacket * Asl, com, jacket + fs\_core * Asl, com, core) / Asl, com = 400.3729$

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

$yv = 0.00154581$

$shv = 0.00494661$

$ftv = 486.7441$

$fyv = 405.62$

$suv = 0.00695956$

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

$lo/lou, min = lb/ld = 0.34790516$

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

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

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

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

with  $fsv = (fs\_jacket * Asl, mid, jacket + fs\_mid * Asl, mid, core) / Asl, mid = 405.62$

```

with Esv = (Esjacket*Asl,mid,jacket + Esmid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04621209
2 = Asl,com/(b*d)*(fs2/fc) = 0.04621209
v = Asl,mid/(b*d)*(fsv/fc) = 0.02857496
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) = 0.05541419
2 = Asl,com/(b*d)*(fs2/fc) = 0.05541419
v = Asl,mid/(b*d)*(fsv/fc) = 0.03426502
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.14932546
Mu = MRc (4.14) = 1.6654E+008
u = su (4.1) = 2.2916591E-005
-----

Calculation of ratio lb/d
-----
Lap Length: lb/d = 0.34790516
lb = 300.00
ld = 862.304
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 645.3439
t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00
-----

Calculation of Mu2+
-----

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 2.2916591E-005
Mu = 1.6654E+008
-----
with full section properties:
b = 670.00
d = 357.00
d' = 43.00
v = 0.0002896
N = 2285.866
fc = 33.00
cc (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00512221
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00512221
we (5.4c) = 0.00164473
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

```

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

$$bo\_2 = 192.00$$

$$ho\_2 = 492.00$$

$$bi2\_2 = 557856.00$$

$$psh, \min * Fywe = \text{Min}(psh, x * Fywe, psh, y * Fywe) = 1.22434$$

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)

$$psh\_x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 2.16539$$

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

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

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

$$h1 = 670.00$$

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

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

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

$$h2 = 500.00$$

$$psh\_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.22434$$

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

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

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

$$h1 = 400.00$$

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

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

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

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 555.55$$

$$fce = 33.00$$

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

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

$$y1 = 0.00154581$$

$$sh1 = 0.00494661$$

$$ft1 = 480.4475$$

$$fy1 = 400.3729$$

$$su1 = 0.00695956$$

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

$$lo/lou, \min = lb/ld = 0.34790516$$

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

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

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

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

$$\text{with } fs1 = (fs, \text{jacket} * Asl, \text{ten, jacket} + fs, \text{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 400.3729$$

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

$$y2 = 0.00154581$$

$$sh2 = 0.00494661$$

$$ft2 = 480.4475$$

$$fy2 = 400.3729$$

$$su2 = 0.00695956$$

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

$$lo/lou, \min = lb/lb, \min = 0.34790516$$

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

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.

$$\text{with } fs2 = (fs, \text{jacket} * Asl, \text{com, jacket} + fs, \text{core} * Asl, \text{com, core}) / Asl, \text{com} = 400.3729$$

with  $E_{s2} = (E_{sjacket} \cdot A_{sl,com,jacket} + E_{s,core} \cdot A_{sl,com,core}) / A_{sl,com} = 200000.00$   
 $y_v = 0.00154581$   
 $sh_v = 0.00494661$   
 $ft_v = 486.7441$   
 $fy_v = 405.62$   
 $suv = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $lo/lo_{u,min} = lb/ld = 0.34790516$   
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fs_v = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fs_v = fsv/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (f_{sjacket} \cdot A_{sl,mid,jacket} + f_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 405.62$   
 with  $E_{sv} = (E_{sjacket} \cdot A_{sl,mid,jacket} + E_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 200000.00$   
 $1 = A_{sl,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.04621209$   
 $2 = A_{sl,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.04621209$   
 $v = A_{sl,mid} / (b \cdot d) \cdot (fsv / fc) = 0.02857496$   
 and confined core properties:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.05541419$   
 $2 = A_{sl,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.05541419$   
 $v = A_{sl,mid} / (b \cdot d) \cdot (fsv / fc) = 0.03426502$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.14932546$   
 $Mu = MRc (4.14) = 1.6654E+008$   
 $u = su (4.1) = 2.2916591E-005$

#### Calculation of ratio $lb/ld$

Lap Length:  $lb/ld = 0.34790516$   
 $lb = 300.00$   
 $ld = 862.304$   
 Calculation of  $lb_{min}$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.  
 $= 1$   
 $db = 15.23077$   
 Mean strength value of all re-bars:  $fy = 645.3439$   
 $t = 1.16154$   
 $s = 0.80$   
 $e = 1.00$   
 $cb = 25.00$   
 $K_{tr} = 2.64216$   
 $n = 13.00$

#### Calculation of $Mu_2$

Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:  
 $u = 2.2916591E-005$   
 $Mu = 1.6654E+008$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0002896$$

$$N = 2285.866$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear\_factor} * \text{Max}(c_u, c_c) = 0.00512221$$

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

$$\text{From (5.4b), TB DY: } c_u = 0.00512221$$

$$w_e(5.4c) = 0.00164473$$

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

$$a_{se1} = 0.14776895$$

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

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

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

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

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

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

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

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.22434$$

Expression ((5.4d), TB DY) 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)

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.16539$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.22434$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00154581$$

$$sh_1 = 0.00494661$$

$$ft_1 = 480.4475$$

$$fy_1 = 400.3729$$

$$su_1 = 0.00695956$$

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

$$l_o / l_{ou, \min} = l_b / l_d = 0.34790516$$

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

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

For calculation of  $esu_1_{\text{nominal}}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered characteristic value  $fsy_1 = fs_1 / 1.2$ , from table 5.1, TB DY.

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

```

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 400.3729
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00154581
sh2 = 0.00494661
ft2 = 480.4475
fy2 = 400.3729
su2 = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.34790516
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 = 400.3729
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00154581
shv = 0.00494661
ftv = 486.7441
fyv = 405.62
suv = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.34790516
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 = 405.62
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04621209
2 = Asl,com/(b*d)*(fs2/fc) = 0.04621209
v = Asl,mid/(b*d)*(fsv/fc) = 0.02857496
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) = 0.05541419
2 = Asl,com/(b*d)*(fs2/fc) = 0.05541419
v = Asl,mid/(b*d)*(fsv/fc) = 0.03426502
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.14932546
Mu = MRc (4.14) = 1.6654E+008
u = su (4.1) = 2.2916591E-005

```

Calculation of ratio lb/lb

```

Lap Length: lb/lb = 0.34790516
lb = 300.00
ld = 862.304
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 645.3439

```



t = 1.16154  
s = 0.80  
e = 1.00  
cb = 25.00  
Ktr = 2.64216  
n = 13.00

Calculation of Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 368172.80$

Calculation of Shear Strength at edge 1,  $V_{r1} = 368172.80$   
 $V_{r1} = V_n$  ((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:  $V_c = 182002.857$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot \text{Area}_{jacket} + f'_{c\_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 28.14925$ , but  $f'_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 6.4841010E-012$   
 $V_u = 4.8511603E-015$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$   
 $V_{s1} = 186169.943$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17, 10.3.4)  
 $V_{s2} = 0.00$  is calculated for jacket, with:  
 $d_2 = 160.00$   
 $A_v = 100530.965$   
 $f_y = 444.44$   
 $s = 300.00$   
 $V_{s2}$  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:  $V_s + V_f \leq 755657.47$

Calculation of Shear Strength at edge 2,  $V_{r2} = 368172.80$   
 $V_{r2} = V_n$  ((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:  $V_c = 182002.857$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot \text{Area}_{jacket} + f'_{c\_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 28.14925$ , but  $f'_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 8.0658469E-012$   
 $V_u = 4.8511603E-015$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$   
 $V_{s1} = 186169.943$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$

s = 150.00

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 = 444.44

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 <= 755657.47

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

At local axis: 2

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

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor, = 0.90

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

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 20.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 444.44$

Concrete Elasticity,  $E_c = 21019.039$

Steel Elasticity,  $E_s = 200000.00$

External Height, H = 670.00

External Width, W = 400.00

Internal Height, H = 500.00

Internal Width, W = 200.00

Cover Thickness, c = 25.00

Element Length, L = 3000.00

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length  $l_b = 300.00$

No FRP Wrapping

Stepwise Properties

Bending Moment, M = 1.1663E+007

Shear Force, V2 = -7.3183079E-015

Shear Force, V3 = 15597.07

Axial Force, F = -7206.737

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: Aslt = 709.9999

-Compression: Aslc = 1668.186

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten = 709.9999

-Compression: Asl,com = 1266.062

-Middle: Asl,mid = 402.1239

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension:  $Asl,ten,jacket = 402.1239$   
 -Compression:  $Asl,com,jacket = 804.2477$   
 -Middle:  $Asl,mid,jacket = 402.1239$   
 Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)  
 -Tension:  $Asl,ten,core = 307.8761$   
 -Compression:  $Asl,com,core = 461.8141$   
 -Middle:  $Asl,mid,core = 0.00$   
 Mean Diameter of Tension Reinforcement,  $DbL = 15.00$

Existing component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u,R = * u = 0.00953564$   
 $u = y + p = 0.01059515$

- Calculation of  $y$  -

$y = (My * Ls / 3) / Eleff = 0.00059515 ((4.29), Biskinis Phd)$   
 $My = 1.8488E+008$   
 $Ls = M/V$  (with  $Ls > 0.1 * L$  and  $Ls < 2 * L$ ) = 747.748  
 From table 10.5, ASCE 41\_17:  $Eleff = 0.3 * Ec * Ig = 7.7426E+013$

Calculation of Yielding Moment  $My$

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

$y = \text{Min}(y_{ten}, y_{com})$   
 $y_{ten} = 3.6520086E-006$   
 with ((10.1), ASCE 41-17)  $fy = \text{Min}(fy, 1.25 * fy * (lb/d)^{2/3}) = 372.8122$   
 $d = 627.00$   
 $y = 0.1859318$   
 $A = 0.00955948$   
 $B = 0.00411088$   
 with  $pt = 0.00283094$   
 $pc = 0.00504809$   
 $pv = 0.00160336$   
 $N = 7206.737$   
 $b = 400.00$   
 $" = 0.06858054$   
 $y_{comp} = 1.9022089E-005$   
 with  $fc = 28.14925$   
 $Ec = 26999.444$   
 $y = 0.18446156$   
 $A = 0.00941709$   
 $B = 0.0040338$   
 with  $Es = 200000.00$

Calculation of ratio  $lb/d$

Lap Length:  $ld/ld,min = 0.43488144$

$lb = 300.00$

$ld = 689.8432$

Calculation of  $l$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$= 1$

$db = 15.23077$

Mean strength value of all re-bars:  $fy = 516.2752$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$Ktr = 2.64216$

$n = 13.00$

- Calculation of  $p$  -

From table 10-7:  $p = 0.01$

with:

- Condition iv occurred

Beam controlled by inadequate embedment into beam-column joint:

( $l_b/d < 1$  and With Lapping in the Vicinity of the End Regions

- Condition i occurred

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

shear control ratio  $V_p/V_o = 0.49656722$

- Transverse Reinforcement: C

- Stirrup Spacing  $\leq d/3$

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

$$= 4.7636209E-006$$

- Stirrup Spacing  $\leq d/2$

$d = d_{\text{external}} = 627.00$

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

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

$V_s = 371407.964$ , already given in calculation of shear control ratio

design Shear = 15597.07

- ( $\rho_t - \rho_c$ )/ $\rho_{bal} = -0.26284228$

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

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

$$\rho_c = A_{sc}/(b_w \cdot d) = 0.00665146$$

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

From (B-1), ACI 318-11:  $\rho_{bal} = 0.0145354$

$$f_c = (f_{c\_jacket} \cdot \text{Area}_{jacket} + f_{c\_core} \cdot \text{Area}_{core}) / \text{section\_area} = 28.14925$$

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

From 10.2.7.3, ACI 318-11:  $\beta_1 = 0.65$

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

$$\gamma = 0.0027778$$

-  $V / (b_w \cdot d \cdot f_c^{0.5}) = 0.14115793$ , NOTE: units in lb & in

$b_w = 400.00$

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

At local axis: 2

Integration Section: (b)

## Calculation No. 7

beam B1, Floor 1

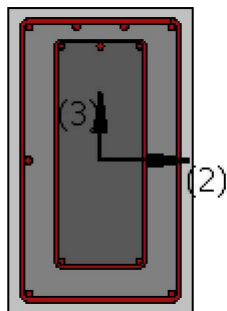
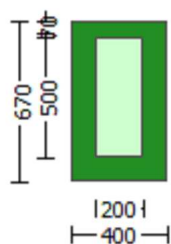
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity  $V_{Rd}$

Edge: End

Local Axis: (3)



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

At local axis: 3

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 0.90$

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

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

Existing material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 16.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 400.00$

Concrete Elasticity,  $E_c = 21019.039$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length  $l_o = l_b = 300.00$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment,  $M_a = 5.6071E+006$

Shear Force,  $V_a = 4084.196$

EDGE -B-

Bending Moment,  $M_b = 1.1663E+007$

Shear Force,  $V_b = 15597.07$

BOTH EDGES

Axial Force,  $F = -7206.737$

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:  $A_{sl, mid} = 402.1239$

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

Existing component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $V_R = V_n = 428124.552$   
 $V_n ((22.5.1.1), ACI 318-14) = 475693.947$

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:  $V_c = 168236.746$   
 $= 1$  (normal-weight concrete)

Mean concrete strength:  $f_c' = (f_c'_{jacket} \cdot Area_{jacket} + f_c'_{core} \cdot Area_{core}) / Area_{section} = 21.64179$ , 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

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / M_u < 1 = 0.71681902$

$M_u = 1.1663E+007$

$V_u = 15597.07$

From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 307457.201$

$V_{s1} = 280648.944$  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)

$V_{s2} = 26808.257$  is calculated for core, with:

$d = 400.00$

$A_v = 100530.965$

$f_y = 400.00$

$s = 300.00$

$V_{s2}$  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:  $V_s + V_f \leq 662579.716$

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

At local axis: 3

Integration Section: (b)

## Calculation No. 8

beam B1, Floor 1

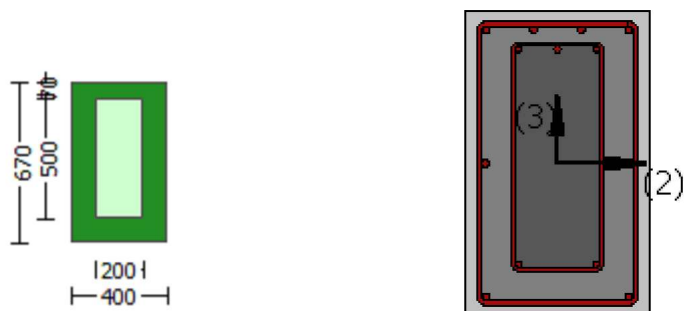
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity ( $\phi$ )

Edge: End

Local Axis: (3)



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

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 0.90$

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 20.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 444.44$

Concrete Elasticity,  $E_c = 21019.039$

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

Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 555.55$

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections  
Lap Length  $l_o = 300.00$   
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,  $F = -2285.866$   
Longitudinal Reinforcement Area Distribution (in 2 divisions)  
-Tension:  $As_t = 709.9999$   
-Compression:  $As_c = 1668.186$   
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $As_{t,ten} = 709.9999$   
-Compression:  $As_{l,com} = 1266.062$   
-Middle:  $As_{l,mid} = 402.1239$

Calculation of Shear Capacity ratio,  $V_e/V_r = 0.49656722$   
Member Controlled by Flexure ( $V_e/V_r < 1$ )  
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 266008.163$   
with  
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 3.8425E+008$   
 $Mu_{1+} = 2.2952E+008$ , 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  
 $Mu_{1-} = 3.8425E+008$ , 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  
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 3.8425E+008$   
 $Mu_{2+} = 2.2952E+008$ , 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  
 $Mu_{2-} = 3.8425E+008$ , 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:  
 $\phi_u = 1.2638035E-005$   
 $M_u = 2.2952E+008$

with full section properties:

$b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027619$   
 $N = 2285.866$   
 $f_c = 33.00$   
 $\phi_o$  (5A.5, TBDY) = 0.002  
Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} \cdot \text{Max}(\phi_u, \phi_o) = 0.00512221$   
The Shear\_factor is considered equal to 1 (pure moment strength)  
From (5.4b), TBDY:  $\phi_u = 0.00512221$   
we (5.4c) = 0.00164473  
 $\phi_{ase}$  ((5.4d), TBDY) =  $(\phi_{ase1} \cdot A_{ext} + \phi_{ase2} \cdot A_{int})/A_{sec} = 0.14776895$



```

ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.22434
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 = 2.16539
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 = 1.22434
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 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00154581
sh1 = 0.00494661
ft1 = 470.5847
fy1 = 392.1539
su1 = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.34790516
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fsjacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 392.1539
with Es1 = (Esjacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00154581
sh2 = 0.00494661
ft2 = 477.682
fy2 = 398.0683
su2 = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.34790516
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  $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 398.0683$

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

$yv = 0.00154581$

$shv = 0.00494661$

$ftv = 515.2755$

$fyv = 429.3962$

$suv = 0.00695956$

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

$lo/lou,min = lb/ld = 0.34790516$

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

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  $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 429.3962$

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

$1 = Asl,ten/(b*d)*(fs1/fc) = 0.03364135$

$2 = Asl,com/(b*d)*(fs2/fc) = 0.06089352$

$v = Asl,mid/(b*d)*(fsv/fc) = 0.02086299$

and confined core properties:

$b = 340.00$

$d = 597.00$

$d' = 13.00$

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

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

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

$1 = Asl,ten/(b*d)*(fs1/fc) = 0.0415669$

$2 = Asl,com/(b*d)*(fs2/fc) = 0.0752394$

$v = Asl,mid/(b*d)*(fsv/fc) = 0.0257781$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su (4.9) = 0.1217168$

$Mu = MRc (4.14) = 2.2952E+008$

$u = su (4.1) = 1.2638035E-005$

-----

Calculation of ratio  $lb/ld$

-----

Lap Length:  $lb/ld = 0.34790516$

$lb = 300.00$

$ld = 862.304$

Calculation of  $lb,min$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$= 1$

$db = 15.23077$

Mean strength value of all re-bars:  $fy = 645.3439$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$Ktr = 2.64216$

$n = 13.00$

-----

-----

Calculation of  $Mu1$ -

-----

-----

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

$$\phi_u = 1.3095001E-005$$

$$M_u = 3.8425E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027619$$

$$N = 2285.866$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.00512221$$

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

$$\text{From (5.4b), TB DY: } \phi_u = 0.00512221$$

$$w_e (5.4c) = 0.00164473$$

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

$$a_{se1} = 0.14776895$$

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

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

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

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

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

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

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

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.22434$$

Expression ((5.4d), TB DY) 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)

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.16539$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.22434$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00154581$$

$$sh_1 = 0.00494661$$

$$f_{t1} = 477.682$$

$$f_{y1} = 398.0683$$

$$su_1 = 0.00695956$$

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

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

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

$$l_o / l_{ou, \min} = l_b / l_d = 0.34790516$$

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

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  $fs1 = (fs\_jacket \cdot Asl\_ten\_jacket + fs\_core \cdot Asl\_ten\_core) / Asl\_ten = 398.0683$   
with  $Es1 = (Es\_jacket \cdot Asl\_ten\_jacket + Es\_core \cdot Asl\_ten\_core) / Asl\_ten = 200000.00$   
 $y2 = 0.00154581$   
 $sh2 = 0.00494661$   
 $ft2 = 470.5847$   
 $fy2 = 392.1539$   
 $su2 = 0.00695956$   
using (30) in Biskinis/Fardis (2013) multiplied with  $shear\_factor$   
and also multiplied by the  $shear\_factor$  according to 15.7.1.4, with  
 $Shear\_factor = 1.00$   
 $lo/lou, min = lb/lb, min = 0.34790516$   
 $su2 = 0.4 \cdot esu2\_nominal ((5.5), TBDY) = 0.032$   
From table 5A.1, TBDY:  $esu2\_nominal = 0.08$ ,  
For calculation of  $esu2\_nominal$  and  $y2, sh2, ft2, fy2$ , it is considered  
characteristic value  $fsy2 = fs2/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
with  $fs2 = (fs\_jacket \cdot Asl\_com\_jacket + fs\_core \cdot Asl\_com\_core) / Asl\_com = 392.1539$   
with  $Es2 = (Es\_jacket \cdot Asl\_com\_jacket + Es\_core \cdot Asl\_com\_core) / Asl\_com = 200000.00$   
 $yv = 0.00154581$   
 $shv = 0.00494661$   
 $ftv = 515.2755$   
 $fyv = 429.3962$   
 $suv = 0.00695956$   
using (30) in Biskinis/Fardis (2013) multiplied with  $shear\_factor$   
and also multiplied by the  $shear\_factor$  according to 15.7.1.4, with  
 $Shear\_factor = 1.00$   
 $lo/lou, min = lb/ld = 0.34790516$   
 $suv = 0.4 \cdot esuv\_nominal ((5.5), TBDY) = 0.032$   
From table 5A.1, TBDY:  $esuv\_nominal = 0.08$ ,  
considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
For calculation of  $esuv\_nominal$  and  $yv, shv, ftv, fyv$ , it is considered  
characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
with  $fsv = (fs\_jacket \cdot Asl\_mid\_jacket + fs\_mid \cdot Asl\_mid\_core) / Asl\_mid = 429.3962$   
with  $Es_v = (Es\_jacket \cdot Asl\_mid\_jacket + Es\_mid \cdot Asl\_mid\_core) / Asl\_mid = 200000.00$   
 $1 = Asl\_ten / (b \cdot d) \cdot (fs1 / fc) = 0.06089352$   
 $2 = Asl\_com / (b \cdot d) \cdot (fs2 / fc) = 0.03364135$   
 $v = Asl\_mid / (b \cdot d) \cdot (fsv / fc) = 0.02086299$

and confined core properties:

$b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl\_ten / (b \cdot d) \cdot (fs1 / fc) = 0.0752394$   
 $2 = Asl\_com / (b \cdot d) \cdot (fs2 / fc) = 0.0415669$   
 $v = Asl\_mid / (b \cdot d) \cdot (fsv / fc) = 0.0257781$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su (4.9) = 0.1523656$   
 $Mu = MRc (4.14) = 3.8425E+008$   
 $u = su (4.1) = 1.3095001E-005$

Calculation of ratio  $lb/ld$

Lap Length:  $lb/ld = 0.34790516$   
 $lb = 300.00$   
 $ld = 862.304$

Calculation of  $l_b, \min$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars:  $f_y = 645.3439$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of  $\mu_{2+}$

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

$$\mu = 1.2638035E-005$$

$$\mu = 2.2952E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027619$$

$$N = 2285.866$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear\_factor} * \text{Max}(\mu, c_o) = 0.00512221$$

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

$$\text{From (5.4b), TBDY: } \mu = 0.00512221$$

$$\mu_e(5.4c) = 0.00164473$$

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

$$a_{se1} = 0.14776895$$

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

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

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

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

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

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

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

$$\mu_{sh, \min} * F_{ywe} = \text{Min}(\mu_{sh, x} * F_{ywe}, \mu_{sh, y} * F_{ywe}) = 1.22434$$

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)

$$\mu_{sh, x} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 2.16539$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$\mu_{sh, y} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 1.22434$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$s1 = 150.00$   
 $s2 = 300.00$   
 $fy_{we1} = 694.45$   
 $fy_{we2} = 555.55$   
 $f_{ce} = 33.00$   
 From ((5.A.5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $y1 = 0.00154581$   
 $sh1 = 0.00494661$   
 $ft1 = 470.5847$   
 $fy1 = 392.1539$   
 $su1 = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou, \min = lb/ld = 0.34790516$   
 $su1 = 0.4 * esu1\_nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,  
 For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered  
 characteristic value  $fsy1 = fs1/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 392.1539$   
 with  $Es1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$   
 $y2 = 0.00154581$   
 $sh2 = 0.00494661$   
 $ft2 = 477.682$   
 $fy2 = 398.0683$   
 $su2 = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou, \min = lb/lb, \min = 0.34790516$   
 $su2 = 0.4 * esu2\_nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esu2\_nominal = 0.08$ ,  
 For calculation of  $esu2\_nominal$  and  $y2, sh2, ft2, fy2$ , it is considered  
 characteristic value  $fsy2 = fs2/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 398.0683$   
 with  $Es2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$   
 $yv = 0.00154581$   
 $shv = 0.00494661$   
 $ftv = 515.2755$   
 $fyv = 429.3962$   
 $suv = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou, \min = lb/ld = 0.34790516$   
 $suv = 0.4 * esuv\_nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv\_nominal = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv\_nominal$  and  $yv, shv, ftv, fyv$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 429.3962$   
 with  $Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$   
 $1 = A_{sl,ten} / (b * d) * (fs1 / f_c) = 0.03364135$   
 $2 = A_{sl,com} / (b * d) * (fs2 / f_c) = 0.06089352$   
 $v = A_{sl,mid} / (b * d) * (fsv / f_c) = 0.02086299$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten} / (b * d) * (fs1 / f_c) = 0.0415669$

$$2 = A_{sl,com}/(b*d)*(f_s2/f_c) = 0.0752394$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.0257781$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

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

---->

$$s_u(4.9) = 0.1217168$$

$$M_u = M_{Rc}(4.14) = 2.2952E+008$$

$$u = s_u(4.1) = 1.2638035E-005$$

Calculation of ratio  $l_b/l_d$

Lap Length:  $l_b/l_d = 0.34790516$

$$l_b = 300.00$$

$$l_d = 862.304$$

Calculation of  $l_b, \min$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars:  $f_y = 645.3439$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of  $M_{u2}$

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

$$u = 1.3095001E-005$$

$$M_u = 3.8425E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027619$$

$$N = 2285.866$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.00512221$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.00512221$$

$$\phi_{we}(5.4c) = 0.00164473$$

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

$$a_{se1} = 0.14776895$$

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

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

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

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

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

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

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

$$\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.22434$$

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)

$$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.16539$$

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

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

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

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

$psh\_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.22434$   
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$   
 $Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$   
 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,  $ns\_2 = 2.00$   
 $h2 = 200.00$

$Asec = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fywe1 = 694.45$   
 $fywe2 = 555.55$   
 $fce = 33.00$

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

$y1 = 0.00154581$   
 $sh1 = 0.00494661$   
 $ft1 = 477.682$   
 $fy1 = 398.0683$   
 $su1 = 0.00695956$

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

$lo/lou, min = lb/ld = 0.34790516$

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

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  $fs1 = (fs\_jacket \cdot Asl, ten, jacket + fs\_core \cdot Asl, ten, core) / Asl, ten = 398.0683$

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

$y2 = 0.00154581$   
 $sh2 = 0.00494661$   
 $ft2 = 470.5847$   
 $fy2 = 392.1539$   
 $su2 = 0.00695956$

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

$lo/lou, min = lb/lb, min = 0.34790516$

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

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  $fs2 = (fs\_jacket \cdot Asl, com, jacket + fs\_core \cdot Asl, com, core) / Asl, com = 392.1539$

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

$yv = 0.00154581$   
 $shv = 0.00494661$   
 $ftv = 515.2755$   
 $fyv = 429.3962$   
 $suv = 0.00695956$

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

$lo/lou, min = lb/ld = 0.34790516$

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

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



considering characteristic value  $f_{sv} = f_{sv}/1.2$ , from table 5.1, TBDY  
For calculation of  $e_{suv\_nominal}$  and  $y_v$ ,  $sh_v$ ,  $ft_v$ ,  $fy_v$ , it is considered  
characteristic value  $f_{sv} = f_{sv}/1.2$ , from table 5.1, TBDY.

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

with  $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 429.3962$

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

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.06089352$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.03364135$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02086299$

and confined core properties:

$b = 340.00$

$d = 597.00$

$d' = 13.00$

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

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

$c$  = confinement factor = 1.00

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.0752394$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.0415669$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.0257781$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su$  (4.9) = 0.1523656

$Mu = MR_c$  (4.14) = 3.8425E+008

$u = su$  (4.1) = 1.3095001E-005

Calculation of ratio  $l_b/l_d$

Lap Length:  $l_b/l_d = 0.34790516$

$l_b = 300.00$

$l_d = 862.304$

Calculation of  $l_{b,min}$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

= 1

$db = 15.23077$

Mean strength value of all re-bars:  $fy = 645.3439$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 535694.165$

Calculation of Shear Strength at edge 1,  $V_{r1} = 535694.165$

$V_{r1} = V_n$  ((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:  $V_c = 194072.856$

= 1 (normal-weight concrete)

Mean concrete strength:  $f'_c = (f'_{c,jacket} \cdot \text{Area}_{jacket} + f'_{c,core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 28.14925$ , but  $f'_c^{0.5} <= 8.3$  MPa (22.5.3.1, ACI 318-14)

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

$A_s$  (tension reinf.) = 709.9999

$b_w = 400.00$

$d = 536.00$

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

$Mu = 1.1086E+006$

$V_u = 9840.632$

From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 341621.309$

$V_{s1} = 311834.654$  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)

$V_{s2} = 29786.655$  is calculated for jacket, with:

$$d_2 = 400.00$$

$$A_v = 100530.965$$

$$f_y = 444.44$$

$$s = 300.00$$

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

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

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

$$\text{From } (11-11), \text{ACI } 440: V_s + V_f \leq 755657.47$$

Calculation of Shear Strength at edge 2,  $V_{r2} = 535694.165$

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

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

From Table (22.5.5.1), ACI 318-14:  $V_c = 194072.856$

= 1 (normal-weight concrete)

Mean concrete strength:  $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.14925$ , but  $f'_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

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

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

$$b_w = 400.00$$

$$d = 536.00$$

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

$$M_u = 1.1086 \text{E}+006$$

$$V_u = 9840.634$$

From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 341621.309$

$V_{s1} = 311834.654$  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)

$V_{s2} = 29786.655$  is calculated for jacket, with:

$$d = 400.00$$

$$A_v = 100530.965$$

$$f_y = 444.44$$

$$s = 300.00$$

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

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

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

$$\text{From } (11-11), \text{ACI } 440: V_s + V_f \leq 755657.47$$

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, = 0.90

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

Consequently:

```

Jacket
New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$ 
New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$ 
Concrete Elasticity,  $E_c = 26999.444$ 
Steel Elasticity,  $E_s = 200000.00$ 
Existing Column
Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 20.00$ 
Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 444.44$ 
Concrete Elasticity,  $E_c = 21019.039$ 
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
Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 555.55$ 
#####
External Height,  $H = 670.00$ 
External Width,  $W = 400.00$ 
Internal Height,  $H = 500.00$ 
Internal Width,  $W = 200.00$ 
Cover Thickness,  $c = 25.00$ 
Mean Confinement Factor overall section = 1.00
Element Length,  $L = 3000.00$ 
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length  $l_o = 300.00$ 
No FRP Wrapping
-----

Stepwise Properties
-----
At local axis: 2
EDGE -A-
Shear Force,  $V_a = 4.8511603E-015$ 
EDGE -B-
Shear Force,  $V_b = -4.8511603E-015$ 
BOTH EDGES
Axial Force,  $F = -2285.866$ 
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension:  $A_{sl} = 709.9999$ 
-Compression:  $A_{sc} = 1668.186$ 
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension:  $A_{sl,ten} = 911.0619$ 
-Compression:  $A_{sl,com} = 911.0619$ 
-Middle:  $A_{sl,mid} = 556.0619$ 
-----
-----

Calculation of Shear Capacity ratio ,  $V_e/V_r = 0.30156355$ 
Member Controlled by Flexure ( $V_e/V_r < 1$ )
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 111027.496$ 
with
 $M_{pr1} = \text{Max}(Mu_{1+} , Mu_{1-}) = 1.6654E+008$ 
 $Mu_{1+} = 1.6654E+008$ , is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
 $Mu_{1-} = 1.6654E+008$ , is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(Mu_{2+} , Mu_{2-}) = 1.6654E+008$ 
 $Mu_{2+} = 1.6654E+008$ , 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
 $Mu_{2-} = 1.6654E+008$ , 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 = 4.8511603E-015, is the shear force acting at edge 1 for the the static loading combination

V2 = -4.8511603E-015, is the shear force acting at edge 2 for the the static loading combination

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

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

$$u = 2.2916591E-005$$

$$Mu = 1.6654E+008$$

-----  
with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0002896$$

$$N = 2285.866$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.00512221$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.00512221$$

$$\phi_{we} \text{ (5.4c)} = 0.00164473$$

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

$$\phi_{ase1} = 0.14776895$$

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

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

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

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

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

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

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

$$\phi_{psh, \min} * F_{ywe} = \text{Min}(\phi_{psh, x} * F_{ywe}, \phi_{psh, y} * F_{ywe}) = 1.22434$$

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)

$$\phi_{psh, x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{ps2} * F_{ywe2} = 2.16539$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$\phi_{psh, y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{ps2} * F_{ywe2} = 1.22434$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

From ((5.A.5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $y1 = 0.00154581$   
 $sh1 = 0.00494661$   
 $ft1 = 480.4475$   
 $fy1 = 400.3729$   
 $su1 = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou,min = lb/ld = 0.34790516$   
 $su1 = 0.4*esu1\_nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,  
 For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered  
 characteristic value  $fsy1 = fs1/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25*(lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 400.3729$   
 with  $Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$   
 $y2 = 0.00154581$   
 $sh2 = 0.00494661$   
 $ft2 = 480.4475$   
 $fy2 = 400.3729$   
 $su2 = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou,min = lb/lb,min = 0.34790516$   
 $su2 = 0.4*esu2\_nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esu2\_nominal = 0.08$ ,  
 For calculation of  $esu2\_nominal$  and  $y2, sh2, ft2, fy2$ , it is considered  
 characteristic value  $fsy2 = fs2/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25*(lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 400.3729$   
 with  $Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$   
 $yv = 0.00154581$   
 $shv = 0.00494661$   
 $ftv = 486.7441$   
 $fyv = 405.62$   
 $suv = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou,min = lb/ld = 0.34790516$   
 $suv = 0.4*esuv\_nominal ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv\_nominal = 0.08$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv\_nominal$  and  $yv, shv, ftv, fyv$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25*(lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 405.62$   
 with  $Es_v = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$   
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.04621209$   
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.04621209$   
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.02857496$   
 and confined core properties:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.05541419$   
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.05541419$   
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.03426502$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)

---

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

---->

$$s_u(4.9) = 0.14932546$$

$$\mu = M_{Rc}(4.14) = 1.6654E+008$$

$$u = s_u(4.1) = 2.2916591E-005$$

Calculation of ratio  $l_b/l_d$

$$\text{Lap Length: } l_b/l_d = 0.34790516$$

$$l_b = 300.00$$

$$l_d = 862.304$$

Calculation of  $l_b, \min$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.  
= 1

$$d_b = 15.23077$$

$$\text{Mean strength value of all re-bars: } f_y = 645.3439$$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of  $\mu_1$ -

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

$$u = 2.2916591E-005$$

$$\mu = 1.6654E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0002896$$

$$N = 2285.866$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear\_factor} * \text{Max}(c_u, c_c) = 0.00512221$$

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

$$\text{From (5.4b), TB DY: } c_u = 0.00512221$$

$$w_e(5.4c) = 0.00164473$$

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

$$a_{se1} = 0.14776895$$

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

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

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

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

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

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

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

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.22434$$

Expression ((5.4d), TB DY) 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)

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.16539$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$psh\_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.22434$   
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00156298$   
 $Ash1 = Astir\_1 * ns\_1 = 157.0796$   
 $\text{No stirups, } ns\_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00025008$   
 $Ash2 = Astir\_2 * ns\_2 = 100.531$   
 $\text{No stirups, } ns\_2 = 2.00$   
 $h2 = 200.00$

$Asec = 268000.00$

$s1 = 150.00$

$s2 = 300.00$

$fywe1 = 694.45$

$fywe2 = 555.55$

$fce = 33.00$

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

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

$y1 = 0.00154581$

$sh1 = 0.00494661$

$ft1 = 480.4475$

$fy1 = 400.3729$

$su1 = 0.00695956$

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

$lo/lou, min = lb/ld = 0.34790516$

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

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  $fs1 = (fs\_jacket * Asl, ten, jacket + fs\_core * Asl, ten, core) / Asl, ten = 400.3729$

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

$y2 = 0.00154581$

$sh2 = 0.00494661$

$ft2 = 480.4475$

$fy2 = 400.3729$

$su2 = 0.00695956$

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

$lo/lou, min = lb/lb, min = 0.34790516$

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

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

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

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

with  $fs2 = (fs\_jacket * Asl, com, jacket + fs\_core * Asl, com, core) / Asl, com = 400.3729$

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

$yv = 0.00154581$

$shv = 0.00494661$

$ftv = 486.7441$

$fyv = 405.62$

$suv = 0.00695956$

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

$lo/lou, min = lb/ld = 0.34790516$

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

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

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

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

with  $fsv = (fs\_jacket * Asl, mid, jacket + fs\_mid * Asl, mid, core) / Asl, mid = 405.62$

```

with Esv = (Esjacket*Asl,mid,jacket + Esmid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04621209
2 = Asl,com/(b*d)*(fs2/fc) = 0.04621209
v = Asl,mid/(b*d)*(fsv/fc) = 0.02857496
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) = 0.05541419
2 = Asl,com/(b*d)*(fs2/fc) = 0.05541419
v = Asl,mid/(b*d)*(fsv/fc) = 0.03426502
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.14932546
Mu = MRc (4.14) = 1.6654E+008
u = su (4.1) = 2.2916591E-005
-----

Calculation of ratio lb/d
-----
Lap Length: lb/d = 0.34790516
lb = 300.00
ld = 862.304
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 645.3439
t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00
-----

Calculation of Mu2+
-----

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 2.2916591E-005
Mu = 1.6654E+008
-----
with full section properties:
b = 670.00
d = 357.00
d' = 43.00
v = 0.0002896
N = 2285.866
fc = 33.00
cc (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00512221
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00512221
we (5.4c) = 0.00164473
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

```



$ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$   
 $psh, \min * Fywe = \text{Min}(psh, x * Fywe, psh, y * Fywe) = 1.22434$   
 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)

$psh\_x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 2.16539$   
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00261799$   
 $Ash1 = Astir\_1 * ns\_1 = 157.0796$   
 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,  $ns\_2 = 2.00$   
 $h2 = 500.00$

$psh\_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.22434$   
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00156298$   
 $Ash1 = Astir\_1 * ns\_1 = 157.0796$   
 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,  $ns\_2 = 2.00$   
 $h2 = 200.00$

$Asec = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fywe1 = 694.45$   
 $fywe2 = 555.55$   
 $fce = 33.00$

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

$y1 = 0.00154581$   
 $sh1 = 0.00494661$   
 $ft1 = 480.4475$   
 $fy1 = 400.3729$   
 $su1 = 0.00695956$

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

$lo/lou, \min = lb/ld = 0.34790516$

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

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  $fs1 = (fs, \text{jacket} * Asl, \text{ten, jacket} + fs, \text{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 400.3729$

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

$y2 = 0.00154581$   
 $sh2 = 0.00494661$   
 $ft2 = 480.4475$   
 $fy2 = 400.3729$   
 $su2 = 0.00695956$

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

$lo/lou, \min = lb/lb, \min = 0.34790516$

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

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

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

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

with  $fs2 = (fs, \text{jacket} * Asl, \text{com, jacket} + fs, \text{core} * Asl, \text{com, core}) / Asl, \text{com} = 400.3729$

with  $E_{s2} = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 200000.00$   
 $y_v = 0.00154581$   
 $sh_v = 0.00494661$   
 $ft_v = 486.7441$   
 $fy_v = 405.62$   
 $suv = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $lo/lo_{min} = lb/ld = 0.34790516$   
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fs_v = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fs_v = fsv/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fsv = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 405.62$   
 with  $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.04621209$   
 $2 = A_{s,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.04621209$   
 $v = A_{s,mid} / (b \cdot d) \cdot (fsv / fc) = 0.02857496$

and confined core properties:

$b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{s,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.05541419$   
 $2 = A_{s,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.05541419$   
 $v = A_{s,mid} / (b \cdot d) \cdot (fsv / fc) = 0.03426502$

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

--->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.14932546$   
 $Mu = MRc (4.14) = 1.6654E+008$   
 $u = su (4.1) = 2.2916591E-005$

Calculation of ratio  $lb/ld$

Lap Length:  $lb/ld = 0.34790516$   
 $lb = 300.00$   
 $ld = 862.304$   
 Calculation of  $lb_{min}$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.  
 $= 1$   
 $db = 15.23077$   
 Mean strength value of all re-bars:  $fy = 645.3439$   
 $t = 1.16154$   
 $s = 0.80$   
 $e = 1.00$   
 $cb = 25.00$   
 $K_{tr} = 2.64216$   
 $n = 13.00$

Calculation of  $Mu_2$ -

Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:  
 $u = 2.2916591E-005$   
 $Mu = 1.6654E+008$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0002896$$

$$N = 2285.866$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear\_factor} * \text{Max}(c_u, c_c) = 0.00512221$$

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

$$\text{From (5.4b), TB DY: } c_u = 0.00512221$$

$$w_e(5.4c) = 0.00164473$$

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

$$a_{se1} = 0.14776895$$

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

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

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

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

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

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

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

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.22434$$

Expression ((5.4d), TB DY) 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)

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.16539$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.22434$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00154581$$

$$sh_1 = 0.00494661$$

$$ft_1 = 480.4475$$

$$fy_1 = 400.3729$$

$$su_1 = 0.00695956$$

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

$$l_o / l_{ou, \min} = l_b / l_d = 0.34790516$$

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

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

For calculation of  $esu_1_{\text{nominal}}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered characteristic value  $fsy_1 = fs_1 / 1.2$ , from table 5.1, TB DY.

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

```

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 400.3729
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00154581
sh2 = 0.00494661
ft2 = 480.4475
fy2 = 400.3729
su2 = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.34790516
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 = 400.3729
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00154581
shv = 0.00494661
ftv = 486.7441
fyv = 405.62
suv = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.34790516
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 = 405.62
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04621209
2 = Asl,com/(b*d)*(fs2/fc) = 0.04621209
v = Asl,mid/(b*d)*(fsv/fc) = 0.02857496
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) = 0.05541419
2 = Asl,com/(b*d)*(fs2/fc) = 0.05541419
v = Asl,mid/(b*d)*(fsv/fc) = 0.03426502
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.14932546
Mu = MRc (4.14) = 1.6654E+008
u = su (4.1) = 2.2916591E-005

```

Calculation of ratio lb/lb

```

Lap Length: lb/lb = 0.34790516
lb = 300.00
lb = 862.304
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 645.3439

```

t = 1.16154  
s = 0.80  
e = 1.00  
cb = 25.00  
Ktr = 2.64216  
n = 13.00

Calculation of Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 368172.80$

Calculation of Shear Strength at edge 1,  $V_{r1} = 368172.80$   
 $V_{r1} = V_n$  ((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:  $V_c = 182002.857$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $fc' = (fc'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + fc'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.14925$ , but  $fc'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 6.4841010E-012$   
 $V_u = 4.8511603E-015$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$   
 $V_{s1} = 186169.943$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17, 10.3.4)  
 $V_{s2} = 0.00$  is calculated for jacket, with:  
 $d_2 = 160.00$   
 $A_v = 100530.965$   
 $f_y = 444.44$   
 $s = 300.00$   
 $V_{s2}$  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:  $V_s + V_f \leq 755657.47$

Calculation of Shear Strength at edge 2,  $V_{r2} = 368172.80$   
 $V_{r2} = V_n$  ((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:  $V_c = 182002.857$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $fc' = (fc'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + fc'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.14925$ , but  $fc'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 8.0658469E-012$   
 $V_u = 4.8511603E-015$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$   
 $V_{s1} = 186169.943$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$

s = 150.00

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 = 444.44

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 <= 755657.47

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, = 0.90

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

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 20.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 444.44$

Concrete Elasticity,  $E_c = 21019.039$

Steel Elasticity,  $E_s = 200000.00$

External Height, H = 670.00

External Width, W = 400.00

Internal Height, H = 500.00

Internal Width, W = 200.00

Cover Thickness, c = 25.00

Element Length, L = 3000.00

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length  $l_b = 300.00$

No FRP Wrapping

Stepwise Properties

Bending Moment, M = 3.8904059E-011

Shear Force, V2 = -7.3183079E-015

Shear Force, V3 = 15597.07

Axial Force, F = -7206.737

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: Aslt = 709.9999

-Compression: Aslc = 1668.186

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten = 911.0619

-Compression: Asl,com = 911.0619

-Middle: Asl,mid = 556.0619

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension:  $Asl,ten,jacket = 603.1858$   
 -Compression:  $Asl,com,jacket = 603.1858$   
 -Middle:  $Asl,mid,jacket = 402.1239$   
 Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)  
 -Tension:  $Asl,ten,core = 307.8761$   
 -Compression:  $Asl,com,core = 307.8761$   
 -Middle:  $Asl,mid,core = 153.938$   
 Mean Diameter of Tension Reinforcement,  $DbL = 15.20$

Existing component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u,R = * u = 0.00689938$   
 $u = y + p = 0.00766598$

- Calculation of  $y$  -

$y = (My * Ls / 3) / Eleff = 0.00266598 ((4.29), Biskinis Phd))$   
 $My = 1.3440E+008$   
 $Ls = M/V$  (with  $Ls > 0.1 * L$  and  $Ls < 2 * L$ ) = 1500.00  
 From table 10.5, ASCE 41\_17:  $Eleff = 0.3 * Ec * Ig = 2.5206E+013$

Calculation of Yielding Moment  $My$

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

$y = \text{Min}(y_{ten}, y_{com})$   
 $y_{ten} = 6.7327472E-006$   
 with ((10.1), ASCE 41-17)  $fy = \text{Min}(fy, 1.25 * fy * (lb/ld)^{2/3}) = 372.8122$   
 $d = 357.00$   
 $y = 0.22446823$   
 $A = 0.01002348$   
 $B = 0.00565094$   
 with  $pt = 0.00380895$   
 $pc = 0.00380895$   
 $pv = 0.00232477$   
 $N = 7206.737$   
 $b = 670.00$   
 $" = 0.12044818$   
 $y_{comp} = 2.7599242E-005$   
 with  $fc = 28.14925$   
 $Ec = 26999.444$   
 $y = 0.22328844$   
 $A = 0.00987419$   
 $B = 0.00557012$   
 with  $Es = 200000.00$

Calculation of ratio  $lb/ld$

Lap Length:  $ld/ld,min = 0.43488144$   
 $lb = 300.00$   
 $ld = 689.8432$

Calculation of  $l$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$= 1$   
 $db = 15.23077$   
 Mean strength value of all re-bars:  $fy = 516.2752$   
 $t = 1.16154$   
 $s = 0.80$   
 $e = 1.00$   
 $cb = 25.00$   
 $Ktr = 2.64216$   
 $n = 13.00$

- Calculation of  $p$  -

From table 10-7:  $p = 0.005$

with:

- Condition iv occurred

Beam controlled by inadequate embedment into beam-column joint:

( $l_b/d < 1$  and With Lapping in the Vicinity of the End Regions

- Condition i occurred

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

shear control ratio  $V_p/V_o = 0.30156355$

- Transverse Reinforcement: NC

- Stirrup Spacing  $> d/3$

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

$= 1.3922438E-022$

- Stirrup Spacing  $\leq d/2$

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

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

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

$V_s = 209999.267$ , already given in calculation of shear control ratio

design Shear =  $7.3183079E-015$

- ( $\lambda - y$ )/  $bal = -0.27560034$

$= Aslt/(bw \cdot d) = 0.00296835$

Tension Reinf Area:  $Aslt = 709.9999$

$' = Aslc/(bw \cdot d) = 0.00697431$

Compression Reinf Area:  $Aslc = 1668.186$

From (B-1), ACI 318-11:  $bal = 0.0145354$

$fc = (fc_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + fc_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{section\_area} = 28.14925$

$fy = fy_{\text{jacket\_bars}} = 555.56$

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

From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000/(87000 + fy) = cb/dt = 0.003/(0.003 + y) = 0.51922877$

$y = 0.0027778$

-  $V/(bw \cdot d \cdot fc^{0.5}) = 6.9447633E-020$ , 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)

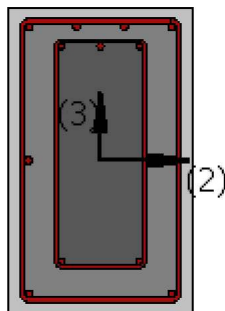
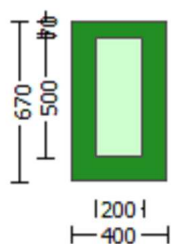
Analysis: Uniform +X

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,  $\gamma = 0.90$

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

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

Consequently:

Jacket

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

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

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

Existing material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 16.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 400.00$

Concrete Elasticity,  $E_c = 21019.039$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length  $l_o = l_b = 300.00$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment,  $M_a = -2.8888022E-011$

Shear Force,  $V_a = 8.5432615E-015$

EDGE -B-

Bending Moment,  $M_b = 5.4215417E-011$

Shear Force,  $V_b = -8.5432615E-015$

BOTH EDGES

Axial Force,  $F = -9649.98$

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,  $DbL_{ten} = 15.20$

Existing component: From table 7-7, ASCE 41-17: Final Shear Capacity  $VR = V_n = 294422.714$   
 $V_n ((22.5.1.1), ACI 318-14) = 327136.349$

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:  $V_c = 159584.741$   
 $= 1$  (normal-weight concrete)  
Mean concrete strength:  $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 21.64179$ , 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  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 2.8888022E-011$   
 $V_u = 8.5432615E-015$   
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:  
 $d = 160.00$   
 $A_v = 100530.965$   
 $f_y = 400.00$   
 $s = 300.00$   
 $V_{s2}$  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:  $V_s + V_f \leq 662579.716$

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

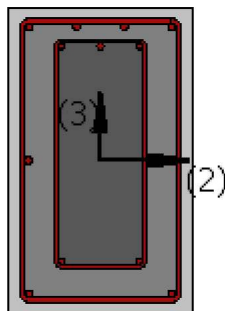
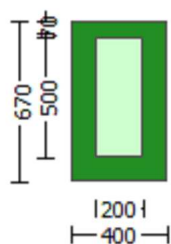
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity ( $\phi_r$ )

Edge: Start

Local Axis: (2)



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

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\gamma = 0.90$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 20.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 444.44$

Concrete Elasticity,  $E_c = 21019.039$

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

Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 555.55$

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length  $l_o = 300.00$

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,  $F = -2285.866$   
 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,  $V_e/V_r = 0.49656722$   
 Member Controlled by Flexure ( $V_e/V_r < 1$ )  
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 266008.163$   
 with  
 $M_{pr1} = \text{Max}(\mu_{1+}, \mu_{1-}) = 3.8425E+008$   
 $\mu_{1+} = 2.2952E+008$ , 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  
 $\mu_{1-} = 3.8425E+008$ , 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  
 $M_{pr2} = \text{Max}(\mu_{2+}, \mu_{2-}) = 3.8425E+008$   
 $\mu_{2+} = 2.2952E+008$ , 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  
 $\mu_{2-} = 3.8425E+008$ , 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:  
 $\phi_u = 1.2638035E-005$   
 $M_u = 2.2952E+008$

with full section properties:

$b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027619$   
 $N = 2285.866$   
 $f_c = 33.00$   
 $\phi_c \text{ (5A.5, TBDY)} = 0.002$   
 Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00512221$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $\phi_u = 0.00512221$   
 $\phi_{ue} \text{ (5.4c)} = 0.00164473$   
 $\phi_{se} \text{ ((5.4d), TBDY)} = (\phi_{se1} \cdot A_{ext} + \phi_{se2} \cdot A_{int})/A_{sec} = 0.14776895$   
 $\phi_{se1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $\phi_{psh,min} \cdot F_{ywe} = \text{Min}(\phi_{psh,x} \cdot F_{ywe}, \phi_{psh,y} \cdot F_{ywe}) = 1.22434$   
 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)

$$\phi_{psh,x} \cdot F_{ywe} = \phi_{psh1} \cdot F_{ywe1} + \phi_{psh2} \cdot F_{ywe2} = 2.16539$$

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00261799$$

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00062519$$

$$Ash2 = Astir_2 \cdot ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.22434$$

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$$

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$$

$$Ash2 = Astir_2 \cdot ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 555.55$$

$$fce = 33.00$$

$$\text{From } ((5A5), \text{ TBDY}), \text{ TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.00154581$$

$$sh1 = 0.00494661$$

$$ft1 = 470.5847$$

$$fy1 = 392.1539$$

$$su1 = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou, \min = lb/ld = 0.34790516$$

$$su1 = 0.4 \cdot esu1_{\text{nominal}} ((5.5), \text{ TBDY}) = 0.032$$

From table 5A.1, TBDY:  $esu1_{\text{nominal}} = 0.08$ ,

For calculation of  $esu1_{\text{nominal}}$  and  $y1, sh1, ft1, fy1$ , it is considered  
characteristic value  $fsy1 = fs1/1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

$$\text{with } fs1 = (fs_{\text{jacket}} \cdot Asl, \text{ten, jacket} + fs_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 392.1539$$

$$\text{with } Es1 = (Es_{\text{jacket}} \cdot Asl, \text{ten, jacket} + Es_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.00154581$$

$$sh2 = 0.00494661$$

$$ft2 = 477.682$$

$$fy2 = 398.0683$$

$$su2 = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 0.34790516$$

$$su2 = 0.4 \cdot esu2_{\text{nominal}} ((5.5), \text{ TBDY}) = 0.032$$

From table 5A.1, TBDY:  $esu2_{\text{nominal}} = 0.08$ ,

For calculation of  $esu2_{\text{nominal}}$  and  $y2, sh2, ft2, fy2$ , it is considered  
characteristic value  $fsy2 = fs2/1.2$ , from table 5.1, TBDY.

$y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

$$\text{with } fs2 = (fs_{\text{jacket}} \cdot Asl, \text{com, jacket} + fs_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 398.0683$$

$$\text{with } Es2 = (Es_{\text{jacket}} \cdot Asl, \text{com, jacket} + Es_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.00154581$$

$$shv = 0.00494661$$

$$ftv = 515.2755$$

$$fyv = 429.3962$$

$$suv = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$l_o/l_{ou,min} = l_b/l_d = 0.34790516$   
 $suv = 0.4 * esuv\_nominal ((5.5), TBDY) = 0.032$   
 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  $fsv = (fs\_jacket * Asl\_mid,jacket + fs\_mid * Asl\_mid,core) / Asl\_mid = 429.3962$   
 with  $Esv = (Es\_jacket * Asl\_mid,jacket + Es\_mid * Asl\_mid,core) / Asl\_mid = 200000.00$   
 $1 = Asl\_ten / (b * d) * (fs1 / fc) = 0.03364135$   
 $2 = Asl\_com / (b * d) * (fs2 / fc) = 0.06089352$   
 $v = Asl\_mid / (b * d) * (fsv / fc) = 0.02086299$

and confined core properties:

$b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl\_ten / (b * d) * (fs1 / fc) = 0.0415669$   
 $2 = Asl\_com / (b * d) * (fs2 / fc) = 0.0752394$   
 $v = Asl\_mid / (b * d) * (fsv / fc) = 0.0257781$

Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)

---->

$v < vs,y2$  - LHS eq.(4.5) is satisfied

---->

$su (4.9) = 0.1217168$   
 $Mu = MRc (4.14) = 2.2952E+008$   
 $u = su (4.1) = 1.2638035E-005$

Calculation of ratio  $l_b/l_d$

Lap Length:  $l_b/l_d = 0.34790516$

$l_b = 300.00$

$l_d = 862.304$

Calculation of  $l_b,min$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.  
 $= 1$

$db = 15.23077$

Mean strength value of all re-bars:  $fy = 645.3439$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$Ktr = 2.64216$

$n = 13.00$

Calculation of  $Mu1$ -

Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:

$u = 1.3095001E-005$

$Mu = 3.8425E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.00027619$

$N = 2285.866$

$fc = 33.00$

$co (5A.5, TBDY) = 0.002$

Final value of  $cu$ :  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00512221$

The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $c_u = 0.00512221$   
 $w_e$  (5.4c) = 0.00164473  
 $a_{se}$  ((5.4d), TBDY) =  $(a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int}) / A_{sec} = 0.14776895$   
 $a_{se1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $p_{sh, \min} \cdot F_{ywe} = \text{Min}(p_{sh, x} \cdot F_{ywe}, p_{sh, y} \cdot F_{ywe}) = 1.22434$   
 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)

$p_{sh, x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 2.16539$   
 $p_{s1}$  (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,  $n_{s\_2} = 2.00$   
 $h_2 = 500.00$

$p_{sh, y} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 1.22434$   
 $p_{s1}$  (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,  $n_{s\_2} = 2.00$   
 $h_2 = 200.00$

$A_{sec} = 268000.00$   
 $s_1 = 150.00$   
 $s_2 = 300.00$   
 $f_{ywe1} = 694.45$   
 $f_{ywe2} = 555.55$   
 $f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY:  $c_c = 0.002$   
 $c$  = confinement factor = 1.00

$y_1 = 0.00154581$   
 $sh_1 = 0.00494661$

$ft_1 = 477.682$

$fy_1 = 398.0683$

$su_1 = 0.00695956$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00

$l_o / l_{ou, \min} = l_b / l_d = 0.34790516$

$su_1 = 0.4 \cdot esu_{1\_nominal}$  ((5.5), TBDY) = 0.032

From table 5A.1, TBDY:  $esu_{1\_nominal} = 0.08$ ,

For calculation of  $esu_{1\_nominal}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered  
 characteristic value  $fsy_1 = fs_1 / 1.2$ , from table 5.1, TBDY.

$y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b / l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs_1 = (f_{s, \text{jacket}} \cdot A_{s, \text{ten, jacket}} + f_{s, \text{core}} \cdot A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 398.0683$

with  $Es_1 = (E_{s, \text{jacket}} \cdot A_{s, \text{ten, jacket}} + E_{s, \text{core}} \cdot A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$

$y_2 = 0.00154581$

$sh_2 = 0.00494661$

$ft_2 = 470.5847$

$fy_2 = 392.1539$

$su_2 = 0.00695956$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with

Shear\_factor = 1.00  
 $l_o/l_{o,min} = l_b/l_{b,min} = 0.34790516$   
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esu_{2,nominal} = 0.08$ ,  
 For calculation of  $esu_{2,nominal}$  and  $y_2, sh_2, ft_2, fy_2$ , it is considered  
 characteristic value  $fsy_2 = fs_2/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 392.1539$   
 with  $Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$   
 $y_v = 0.00154581$   
 $sh_v = 0.00494661$   
 $ft_v = 515.2755$   
 $fy_v = 429.3962$   
 $suv = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $l_o/l_{o,min} = l_b/l_d = 0.34790516$   
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fsv = fs_v/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fsv = fs_v/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_v = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 429.3962$   
 with  $Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$   
 $1 = A_{sl,ten} / (b * d) * (fs_1 / f_c) = 0.06089352$   
 $2 = A_{sl,com} / (b * d) * (fs_2 / f_c) = 0.03364135$   
 $v = A_{sl,mid} / (b * d) * (fs_v / f_c) = 0.02086299$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten} / (b * d) * (fs_1 / f_c) = 0.0752394$   
 $2 = A_{sl,com} / (b * d) * (fs_2 / f_c) = 0.0415669$   
 $v = A_{sl,mid} / (b * d) * (fs_v / f_c) = 0.0257781$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < v_{s,y_2}$  - LHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.1523656$   
 $Mu = MRc (4.14) = 3.8425E+008$   
 $u = su (4.1) = 1.3095001E-005$

#### Calculation of ratio $l_b/l_d$

Lap Length:  $l_b/l_d = 0.34790516$   
 $l_b = 300.00$   
 $l_d = 862.304$   
 Calculation of  $l_{b,min}$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.  
 $= 1$   
 $db = 15.23077$   
 Mean strength value of all re-bars:  $fy = 645.3439$   
 $t = 1.16154$   
 $s = 0.80$   
 $e = 1.00$   
 $cb = 25.00$   
 $K_{tr} = 2.64216$   
 $n = 13.00$



## Calculation of $\mu_{2+}$

Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:

$$\mu = 1.2638035E-005$$

$$\mu = 2.2952E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027619$$

$$N = 2285.866$$

$$f_c = 33.00$$

$$cc(5A.5, TBDY) = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear\_factor} * \text{Max}(\mu, cc) = 0.00512221$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu = 0.00512221$$

$$\mu_e(5.4c) = 0.00164473$$

$$ase((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

$$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.22434$$

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)

$$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.16539$$

$$ps1(\text{external}) = (A_{sh1} * h1 / s1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2(\text{internal}) = (A_{sh2} * h2 / s2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.22434$$

$$ps1(\text{external}) = (A_{sh1} * h1 / s1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2(\text{internal}) = (A_{sh2} * h2 / s2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.00154581$$

$$sh1 = 0.00494661$$

$$ft1 = 470.5847$$

$$fy1 = 392.1539$$

$$su1 = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor

and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00  
 $lo/lou,min = lb/ld = 0.34790516$   
 $su1 = 0.4*esu1\_nominal ((5.5), TBDY) = 0.032$   
From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,  
For calculation of  $esu1\_nominal$  and  $y1, sh1,ft1,fy1$ , it is considered  
characteristic value  $fsy1 = fs1/1.2$ , from table 5.1, TBDY.  
 $y1, sh1,ft1,fy1$ , are also multiplied by  $Min(1,1.25*(lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
with  $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 392.1539$   
with  $Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$   
 $y2 = 0.00154581$   
 $sh2 = 0.00494661$   
 $ft2 = 477.682$   
 $fy2 = 398.0683$   
 $su2 = 0.00695956$   
using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00  
 $lo/lou,min = lb/lb,min = 0.34790516$   
 $su2 = 0.4*esu2\_nominal ((5.5), TBDY) = 0.032$   
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  $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 398.0683$   
with  $Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$   
 $yv = 0.00154581$   
 $shv = 0.00494661$   
 $ftv = 515.2755$   
 $fyv = 429.3962$   
 $suv = 0.00695956$   
using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00  
 $lo/lou,min = lb/ld = 0.34790516$   
 $suv = 0.4*esuv\_nominal ((5.5), TBDY) = 0.032$   
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  $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 429.3962$   
with  $Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$   
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.03364135$   
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.06089352$   
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.02086299$   
and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.0415669$   
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.0752394$   
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.0257781$   
Case/Assumption: Unconfined full section - Steel rupture  
'satisfies Eq. (4.3)  
--->  
 $v < vs,y2$  - LHS eq.(4.5) is satisfied  
--->  
 $su (4.9) = 0.1217168$   
 $Mu = MRc (4.14) = 2.2952E+008$   
 $u = su (4.1) = 1.2638035E-005$

-----  
Calculation of ratio  $lb/ld$

Lap Length:  $l_b/l_d = 0.34790516$

$l_b = 300.00$

$l_d = 862.304$

Calculation of  $l_b$ , min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$= 1$

$db = 15.23077$

Mean strength value of all re-bars:  $f_y = 645.3439$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of  $\mu_2$ -

Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:

$\mu = 1.3095001E-005$

$\mu_u = 3.8425E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.00027619$

$N = 2285.866$

$f_c = 33.00$

$\phi$  (5A.5, TBDY) = 0.002

Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.00512221$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $\phi_u = 0.00512221$

$\phi_{we}$  (5.4c) = 0.00164473

$a_{se}$  ((5.4d), TBDY) =  $(a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o\_1} = 340.00$

$h_{o\_1} = 610.00$

$b_{i2\_1} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o\_2} = 192.00$

$h_{o\_2} = 492.00$

$b_{i2\_2} = 557856.00$

$\phi_{sh,min} * F_{ywe} = \text{Min}(\phi_{sh,x} * F_{ywe}, \phi_{sh,y} * F_{ywe}) = 1.22434$

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)

$\phi_{sh,x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.16539$

$\phi_{sh1}$  (external) =  $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$

No stirrups,  $n_{s\_1} = 2.00$

$h_1 = 670.00$

$\phi_{sh2}$  (internal) =  $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$

$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$

No stirrups,  $n_{s\_2} = 2.00$

$h_2 = 500.00$

$\phi_{sh,y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.22434$

$\phi_{sh1}$  (external) =  $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$

$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$

No stirrups,  $n_{s\_1} = 2.00$

$h_1 = 400.00$

$\phi_{sh2}$  (internal) =  $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$

$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$

No stirrups, ns\_2 = 2.00  
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 555.55

fce = 33.00

From ((5A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00154581

sh1 = 0.00494661

ft1 = 477.682

fy1 = 398.0683

su1 = 0.00695956

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

lo/lou,min = lb/lb = 0.34790516

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 = 398.0683

with Es1 = (Es,jacket\*Asl,ten,jacket + Es,core\*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00154581

sh2 = 0.00494661

ft2 = 470.5847

fy2 = 392.1539

su2 = 0.00695956

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

lo/lou,min = lb/lb,min = 0.34790516

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 = 392.1539

with Es2 = (Es,jacket\*Asl,com,jacket + Es,core\*Asl,com,core)/Asl,com = 200000.00

yv = 0.00154581

shv = 0.00494661

ftv = 515.2755

fyv = 429.3962

suv = 0.00695956

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

lo/lou,min = lb/lb = 0.34790516

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 = 429.3962

with Esv = (Es,jacket\*Asl,mid,jacket + Es,mid\*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.06089352

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.03364135

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.02086299

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

$f_{cc}$  (5A.2, TBDY) = 33.00  
 $c_c$  (5A.5, TBDY) = 0.002  
 $c$  = confinement factor = 1.00  
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.0752394$   
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.0415669$   
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.0257781$   
 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) = 0.1523656  
 $M_u = M_{Rc}$  (4.14) = 3.8425E+008  
 $u = \mu_u$  (4.1) = 1.3095001E-005

Calculation of ratio  $l_b/l_d$

Lap Length:  $l_b/l_d = 0.34790516$   
 $l_b = 300.00$   
 $l_d = 862.304$   
 Calculation of  $l_b$ ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.  
 $= 1$   
 $db = 15.23077$   
 Mean strength value of all re-bars:  $f_y = 645.3439$   
 $t = 1.16154$   
 $s = 0.80$   
 $e = 1.00$   
 $cb = 25.00$   
 $K_{tr} = 2.64216$   
 $n = 13.00$

Calculation of Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 535694.165$

Calculation of Shear Strength at edge 1,  $V_{r1} = 535694.165$   
 $V_{r1} = V_n$  ((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:  $V_c = 194072.856$   
 $= 1$  (normal-weight concrete)  
 Mean concrete strength:  $f'_c = (f'_{c,jacket} * \text{Area}_{jacket} + f'_{c,core} * \text{Area}_{core}) / \text{Area}_{section} = 28.14925$ , but  $f_c^{0.5} < =$   
 8.3 MPa (22.5.3.1, ACI 318-14)  
 $p_w = A_s / (b_w * d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u * d / M_u < 1 = 1.00$   
 $M_u = 1.1086E+006$   
 $V_u = 9840.632$   
 From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 341621.309$   
 $V_{s1} = 311834.654$  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)  
 $V_{s2} = 29786.655$  is calculated for jacket, with:  
 $d_2 = 400.00$   
 $A_v = 100530.965$   
 $f_y = 444.44$   
 $s = 300.00$   
 $V_{s2}$  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:  $V_s + V_f \leq 755657.47$

Calculation of Shear Strength at edge 2,  $V_{r2} = 535694.165$   
 $V_{r2} = V_n ((22.5.1.1), \text{ACI } 318-14)$

NOTE: In expression (22.5.1.1) ' $V_w$ ' is replaced by ' $V_w + f^*V_f$ '  
where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 194072.856$   
 $= 1$  (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.14925$ , 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  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / M_u < 1 = 1.00$   
 $M_u = 1.1086 \text{E}+006$   
 $V_u = 9840.634$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 341621.309$   
 $V_{s1} = 311834.654$  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)  
 $V_{s2} = 29786.655$  is calculated for jacket, with:  
 $d = 400.00$   
 $A_v = 100530.965$   
 $f_y = 444.44$   
 $s = 300.00$   
 $V_{s2}$  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:  $V_s + V_f \leq 755657.47$

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,  $\phi = 0.90$   
Mean strength values are used for both shear and moment calculations.  
Consequently:  
Jacket  
New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$   
New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$   
Concrete Elasticity,  $E_c = 26999.444$   
Steel Elasticity,  $E_s = 200000.00$   
Existing Column  
Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 20.00$   
Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 444.44$   
Concrete Elasticity,  $E_c = 21019.039$   
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
Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 555.55$ 
#####
External Height,  $H = 670.00$ 
External Width,  $W = 400.00$ 
Internal Height,  $H = 500.00$ 
Internal Width,  $W = 200.00$ 
Cover Thickness,  $c = 25.00$ 
Mean Confinement Factor overall section = 1.00
Element Length,  $L = 3000.00$ 
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length  $l_o = 300.00$ 
No FRP Wrapping
-----

Stepwise Properties
-----
At local axis: 2
EDGE -A-
Shear Force,  $V_a = 4.8511603E-015$ 
EDGE -B-
Shear Force,  $V_b = -4.8511603E-015$ 
BOTH EDGES
Axial Force,  $F = -2285.866$ 
Longitudinal Reinforcement Area Distribution (in 2 divisions)
  -Tension:  $A_{sl,t} = 709.9999$ 
  -Compression:  $A_{sl,c} = 1668.186$ 
Longitudinal Reinforcement Area Distribution (in 3 divisions)
  -Tension:  $A_{sl,ten} = 911.0619$ 
  -Compression:  $A_{sl,com} = 911.0619$ 
  -Middle:  $A_{sl,mid} = 556.0619$ 
-----
-----

Calculation of Shear Capacity ratio ,  $V_e/V_r = 0.30156355$ 
Member Controlled by Flexure ( $V_e/V_r < 1$ )
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 111027.496$ 
with
 $M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 1.6654E+008$ 
 $M_{u1+} = 1.6654E+008$ , is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
 $M_{u1-} = 1.6654E+008$ , is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 1.6654E+008$ 
 $M_{u2+} = 1.6654E+008$ , is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
 $M_{u2-} = 1.6654E+008$ , 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
 $V_1 = 4.8511603E-015$ , is the shear force acting at edge 1 for the the static loading combination
 $V_2 = -4.8511603E-015$ , is the shear force acting at edge 2 for the the static loading combination
-----

Calculation of  $M_{u1+}$ 
-----

Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

```

u = 2.2916591E-005  
Mu = 1.6654E+008

with full section properties:

b = 670.00  
d = 357.00  
d' = 43.00  
v = 0.0002896  
N = 2285.866  
fc = 33.00  
co (5A.5, TBDY) = 0.002  
Final value of cu: cu\* = shear\_factor \* Max( cu, cc) = 0.00512221  
The Shear\_factor is considered equal to 1 (pure moment strength)  
From (5.4b), TBDY: cu = 0.00512221  
we (5.4c) = 0.00164473  
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) = 1.22434  
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 = 2.16539  
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 = 1.22434  
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 = 555.55  
fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.002  
c = confinement factor = 1.00  
y1 = 0.00154581  
sh1 = 0.00494661  
ft1 = 480.4475  
fy1 = 400.3729  
su1 = 0.00695956  
using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00  
lo/lou,min = lb/d = 0.34790516  
su1 = 0.4\*esu1\_nominal ((5.5), TBDY) = 0.032  
From table 5A.1, TBDY: esu1\_nominal = 0.08,



For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered characteristic value  $fsy1 = fs1/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25*(lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 400.3729$   
 with  $Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$   
 $y2 = 0.00154581$   
 $sh2 = 0.00494661$   
 $ft2 = 480.4475$   
 $fy2 = 400.3729$   
 $su2 = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $lo/lou,min = lb/lb,min = 0.34790516$   
 $su2 = 0.4*esu2\_nominal ((5.5), TBDY) = 0.032$   
 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  $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 400.3729$   
 with  $Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$   
 $yv = 0.00154581$   
 $shv = 0.00494661$   
 $ftv = 486.7441$   
 $fyv = 405.62$   
 $suv = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $lo/lou,min = lb/ld = 0.34790516$   
 $suv = 0.4*esuv\_nominal ((5.5), TBDY) = 0.032$   
 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  $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 405.62$   
 with  $Es_v = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$   
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.04621209$   
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.04621209$   
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.02857496$

and confined core properties:

$b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.05541419$   
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.05541419$   
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.03426502$

Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)

--->

$v < vs,y2$  - LHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.14932546$   
 $Mu = MRc (4.14) = 1.6654E+008$   
 $u = su (4.1) = 2.2916591E-005$

Calculation of ratio  $lb/ld$

Lap Length:  $lb/ld = 0.34790516$

$lb = 300.00$

$ld = 862.304$

Calculation of  $lb,min$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

```

= 1
db = 15.23077
Mean strength value of all re-bars: fy = 645.3439
t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

```

Calculation of Mu1-

Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

```

u = 2.2916591E-005
Mu = 1.6654E+008

```

with full section properties:

```

b = 670.00
d = 357.00
d' = 43.00
v = 0.0002896
N = 2285.866
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of  $\phi_u$ :  $\phi_u = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.00512221$ 
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY:  $\phi_u = 0.00512221$ 
 $\phi_{ue}$  (5.4c) = 0.00164473
 $\phi_{se}$  ((5.4d), TBDY) =  $(\phi_{se1} * A_{ext} + \phi_{se2} * A_{int}) / A_{sec} = 0.14776895$ 
 $\phi_{se1} = 0.14776895$ 
 $b_{o1} = 340.00$ 
 $h_{o1} = 610.00$ 
 $b_{i21} = 975400.00$ 
 $\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$ 
 $b_{o2} = 192.00$ 
 $h_{o2} = 492.00$ 
 $b_{i22} = 557856.00$ 
 $\phi_{sh,min} * F_{ywe} = \text{Min}(\phi_{sh,x} * F_{ywe}, \phi_{sh,y} * F_{ywe}) = 1.22434$ 
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)

```

```

 $\phi_{sh,x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.16539$ 
 $\phi_{sh1}$  (external) =  $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$ 
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$ 
No stirrups,  $n_{s\_1} = 2.00$ 
 $h_1 = 670.00$ 
 $\phi_{sh2}$  (internal) =  $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$ 
 $A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$ 
No stirrups,  $n_{s\_2} = 2.00$ 
 $h_2 = 500.00$ 

```

```

 $\phi_{sh,y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.22434$ 
 $\phi_{sh1}$  (external) =  $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$ 
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$ 
No stirrups,  $n_{s\_1} = 2.00$ 
 $h_1 = 400.00$ 
 $\phi_{sh2}$  (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 = 555.55
fce = 33.00
From ((5A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00154581
sh1 = 0.00494661
ft1 = 480.4475
fy1 = 400.3729
su1 = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.34790516
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 = 400.3729
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00154581
sh2 = 0.00494661
ft2 = 480.4475
fy2 = 400.3729
su2 = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.34790516
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 = 400.3729
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00154581
shv = 0.00494661
ftv = 486.7441
fyv = 405.62
suv = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.34790516
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 = 405.62
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04621209
2 = Asl,com/(b*d)*(fs2/fc) = 0.04621209
v = Asl,mid/(b*d)*(fsv/fc) = 0.02857496
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) = 0.05541419
2 = Asl,com/(b*d)*(fs2/fc) = 0.05541419

```

$v = A_{sl, mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.03426502$   
Case/Assumption: Unconfined full section - Steel rupture  
satisfies Eq. (4.3)

--->  
 $v < v_{s, y2}$  - LHS eq.(4.5) is satisfied  
--->  
 $\mu_u (4.9) = 0.14932546$   
 $\mu_u = M_{Rc} (4.14) = 1.6654E+008$   
 $u = \mu_u (4.1) = 2.2916591E-005$

-----  
Calculation of ratio  $l_b / l_d$

-----  
Lap Length:  $l_b / l_d = 0.34790516$   
 $l_b = 300.00$   
 $l_d = 862.304$   
Calculation of  $l_b, min$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.  
 $= 1$   
 $d_b = 15.23077$   
Mean strength value of all re-bars:  $f_y = 645.3439$   
 $t = 1.16154$   
 $s = 0.80$   
 $e = 1.00$   
 $c_b = 25.00$   
 $K_{tr} = 2.64216$   
 $n = 13.00$

-----  
Calculation of  $\mu_{u2+}$

-----  
Calculation of ultimate curvature  $\mu_u$  according to 4.1, Biskinis/Fardis 2013:  
 $u = 2.2916591E-005$   
 $\mu_u = 1.6654E+008$

-----  
with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.0002896$   
 $N = 2285.866$   
 $f_c = 33.00$   
 $\phi (5A.5, TBDY) = 0.002$   
Final value of  $\phi$ :  $\phi_u = \text{shear\_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00512221$   
The Shear\_factor is considered equal to 1 (pure moment strength)  
From (5.4b), TBDY:  $\phi_u = 0.00512221$   
 $\phi_{we} (5.4c) = 0.00164473$   
 $\phi_{ase} ((5.4d), TBDY) = (\phi_{ase1} \cdot A_{ext} + \phi_{ase2} \cdot A_{int}) / A_{sec} = 0.14776895$   
 $\phi_{ase1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $\phi_{ase2} = \text{Max}(\phi_{ase1}, \phi_{ase2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $\phi_{psh, min} \cdot F_{ywe} = \text{Min}(\phi_{psh, x} \cdot F_{ywe}, \phi_{psh, y} \cdot F_{ywe}) = 1.22434$   
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)

-----  
 $\phi_{psh, x} \cdot F_{ywe} = \phi_{psh1} \cdot F_{ywe1} + \phi_{psh2} \cdot F_{ywe2} = 2.16539$   
 $\phi_{ps1} (\text{external}) = (A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} \cdot n_{s\_1} = 157.0796$   
No stirrups,  $n_{s\_1} = 2.00$   
 $h_1 = 670.00$

$$ps_2 \text{ (internal)} = (Ash_2 * h_2 / s_2) / A_{sec} = 0.00062519$$

$$Ash_2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h_2 = 500.00$$

$$psh_y * Fy_{we} = psh_1 * Fy_{we1} + ps_2 * Fy_{we2} = 1.22434$$

$$ps_1 \text{ (external)} = (Ash_1 * h_1 / s_1) / A_{sec} = 0.00156298$$

$$Ash_1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h_1 = 400.00$$

$$ps_2 \text{ (internal)} = (Ash_2 * h_2 / s_2) / A_{sec} = 0.00025008$$

$$Ash_2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$fy_{we1} = 694.45$$

$$fy_{we2} = 555.55$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A.5), TBDY), TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.00154581$$

$$sh_1 = 0.00494661$$

$$ft_1 = 480.4475$$

$$fy_1 = 400.3729$$

$$su_1 = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou, \min = lb/ld = 0.34790516$$

$$su_1 = 0.4 * esu_1 \text{ nominal ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu_1 \text{ nominal} = 0.08,$$

For calculation of  $esu_1 \text{ nominal}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered  
characteristic value  $fsy_1 = fs_1 / 1.2$ , from table 5.1, TBDY.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_1 = (fs_{jacket} * Asl, \text{ten, jacket} + fs_{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 400.3729$$

$$\text{with } Es_1 = (Es_{jacket} * Asl, \text{ten, jacket} + Es_{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y_2 = 0.00154581$$

$$sh_2 = 0.00494661$$

$$ft_2 = 480.4475$$

$$fy_2 = 400.3729$$

$$su_2 = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 0.34790516$$

$$su_2 = 0.4 * esu_2 \text{ nominal ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu_2 \text{ nominal} = 0.08,$$

For calculation of  $esu_2 \text{ nominal}$  and  $y_2, sh_2, ft_2, fy_2$ , it is considered  
characteristic value  $fsy_2 = fs_2 / 1.2$ , from table 5.1, TBDY.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_2 = (fs_{jacket} * Asl, \text{com, jacket} + fs_{core} * Asl, \text{com, core}) / Asl, \text{com} = 400.3729$$

$$\text{with } Es_2 = (Es_{jacket} * Asl, \text{com, jacket} + Es_{core} * Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$y_v = 0.00154581$$

$$sh_v = 0.00494661$$

$$ft_v = 486.7441$$

$$fy_v = 405.62$$

$$su_v = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou, \min = lb/ld = 0.34790516$$

$$su_v = 0.4 * esuv \text{ nominal ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esuv \text{ nominal} = 0.08,$$

considering characteristic value  $fsyv = fs_v / 1.2$ , from table 5.1, TBDY

For calculation of  $esuv\_nominal$  and  $y_v$ ,  $sh_v$ ,  $ft_v$ ,  $fy_v$ , it is considered characteristic value  $f_{sv} = f_{sv}/1.2$ , from table 5.1, TBDY.

$y_1$ ,  $sh_1$ ,  $ft_1$ ,  $fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $f_{sv} = (f_{s,jacket} \cdot A_{sl,mid,jacket} + f_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 405.62$

with  $E_{sv} = (E_{s,jacket} \cdot A_{sl,mid,jacket} + E_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 200000.00$

$1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.04621209$

$2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.04621209$

$v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02857496$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

$f_{cc} \text{ (5A.2, TBDY)} = 33.00$

$cc \text{ (5A.5, TBDY)} = 0.002$

$c = \text{confinement factor} = 1.00$

$1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.05541419$

$2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.05541419$

$v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.03426502$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$  - LHS eq.(4.5) is satisfied

--->

$su \text{ (4.9)} = 0.14932546$

$Mu = MRc \text{ (4.14)} = 1.6654E+008$

$u = su \text{ (4.1)} = 2.2916591E-005$

Calculation of ratio  $lb/ld$

Lap Length:  $lb/ld = 0.34790516$

$lb = 300.00$

$ld = 862.304$

Calculation of  $lb_{min}$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$= 1$

$db = 15.23077$

Mean strength value of all re-bars:  $fy = 645.3439$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of  $Mu_2$ -

Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:

$u = 2.2916591E-005$

$Mu = 1.6654E+008$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.0002896$

$N = 2285.866$

$f_c = 33.00$

$co \text{ (5A.5, TBDY)} = 0.002$

Final value of  $cu$ :  $cu^* = \text{shear\_factor} \cdot \text{Max}(cu, cc) = 0.00512221$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $cu = 0.00512221$

$we \text{ (5.4c)} = 0.00164473$

$ase \text{ ((5.4d), TBDY)} = (ase_1 \cdot A_{ext} + ase_2 \cdot A_{int}) / A_{sec} = 0.14776895$

```

ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = 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) = 1.22434
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 = 2.16539
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 = 1.22434
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 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00154581
sh1 = 0.00494661
ft1 = 480.4475
fy1 = 400.3729
su1 = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.34790516
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fsjacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 400.3729
with Es1 = (Esjacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00154581
sh2 = 0.00494661
ft2 = 480.4475
fy2 = 400.3729
su2 = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.34790516
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  $Min(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs2 = (fs\_jacket \cdot Asl,com,jacket + fs\_core \cdot Asl,com,core) / Asl,com = 400.3729$

with  $Es2 = (Es\_jacket \cdot Asl,com,jacket + Es\_core \cdot Asl,com,core) / Asl,com = 200000.00$

$yv = 0.00154581$

$shv = 0.00494661$

$ftv = 486.7441$

$fyv = 405.62$

$suv = 0.00695956$

using (30) in Biskinis/Fardis (2013) multiplied with  $shear\_factor$  and also multiplied by the  $shear\_factor$  according to 15.7.1.4, with  $Shear\_factor = 1.00$

$lo/lou,min = lb/ld = 0.34790516$

$suv = 0.4 \cdot esuv\_nominal ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY:  $esuv\_nominal = 0.08$ ,

considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY

For calculation of  $esuv\_nominal$  and  $yv$ ,  $shv, ftv, fyv$ , it is considered characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.

$y1$ ,  $sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fsv = (fs\_jacket \cdot Asl,mid,jacket + fs\_mid \cdot Asl,mid,core) / Asl,mid = 405.62$

with  $Es_v = (Es\_jacket \cdot Asl,mid,jacket + Es\_mid \cdot Asl,mid,core) / Asl,mid = 200000.00$

$1 = Asl,ten/(b \cdot d) \cdot (fs1/fc) = 0.04621209$

$2 = Asl,com/(b \cdot d) \cdot (fs2/fc) = 0.04621209$

$v = Asl,mid/(b \cdot d) \cdot (fsv/fc) = 0.02857496$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

$fcc (5A.2, TBDY) = 33.00$

$cc (5A.5, TBDY) = 0.002$

$c = \text{confinement factor} = 1.00$

$1 = Asl,ten/(b \cdot d) \cdot (fs1/fc) = 0.05541419$

$2 = Asl,com/(b \cdot d) \cdot (fs2/fc) = 0.05541419$

$v = Asl,mid/(b \cdot d) \cdot (fsv/fc) = 0.03426502$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < vs,y2$  - LHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.14932546$

$Mu = MRc (4.14) = 1.6654E+008$

$u = su (4.1) = 2.2916591E-005$

-----

Calculation of ratio  $lb/ld$

-----

Lap Length:  $lb/ld = 0.34790516$

$lb = 300.00$

$ld = 862.304$

Calculation of  $lb,min$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$= 1$

$db = 15.23077$

Mean strength value of all re-bars:  $fy = 645.3439$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$Ktr = 2.64216$

$n = 13.00$

-----

-----

-----

Calculation of Shear Strength  $Vr = Min(Vr1, Vr2) = 368172.80$

-----

Calculation of Shear Strength at edge 1,  $Vr1 = 368172.80$



$Vr1 = Vn$  ((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:  $Vc = 182002.857$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 28.14925$ , but  $fc'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $pw = As / (bw \cdot d) = 0.00331157$   
 $As$  (tension reinf.) = 709.9999  
 $bw = 670.00$   
 $d = 320.00$   
 $Vu \cdot d / Mu < 1 = 0.00$   
 $Mu = 6.4841010E-012$   
 $Vu = 4.8511603E-015$   
From (11.5.4.8), ACI 318-14:  $Vs1 + Vs2 = 186169.943$   
 $Vs1 = 186169.943$  is calculated for jacket, with:  
 $d = 320.00$   
 $Av = 157079.633$   
 $fy = 555.56$   
 $s = 150.00$   
 $Vs1$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $Vs2 = 0.00$  is calculated for jacket, with:  
 $d2 = 160.00$   
 $Av = 100530.965$   
 $fy = 444.44$   
 $s = 300.00$   
 $Vs2$  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:  $Vs + Vf \leq 755657.47$

Calculation of Shear Strength at edge 2,  $Vr2 = 368172.80$   
 $Vr2 = Vn$  ((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:  $Vc = 182002.857$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 28.14925$ , but  $fc'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $pw = As / (bw \cdot d) = 0.00331157$   
 $As$  (tension reinf.) = 709.9999  
 $bw = 670.00$   
 $d = 320.00$   
 $Vu \cdot d / Mu < 1 = 0.00$   
 $Mu = 8.0658469E-012$   
 $Vu = 4.8511603E-015$   
From (11.5.4.8), ACI 318-14:  $Vs1 + Vs2 = 186169.943$   
 $Vs1 = 186169.943$  is calculated for jacket, with:  
 $d = 320.00$   
 $Av = 157079.633$   
 $fy = 555.56$   
 $s = 150.00$   
 $Vs1$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $Vs2 = 0.00$  is calculated for jacket, with:  
 $d = 160.00$   
 $Av = 100530.965$   
 $fy = 444.44$   
 $s = 300.00$   
 $Vs2$  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:  $Vs + Vf \leq 755657.47$

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,  $\gamma = 0.90$

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 20.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 444.44$

Concrete Elasticity,  $E_c = 21019.039$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length  $l_b = 300.00$

No FRP Wrapping

#### Stepwise Properties

Bending Moment,  $M = 8.9415E+006$

Shear Force,  $V_2 = 8.5432615E-015$

Shear Force,  $V_3 = 1226.091$

Axial Force,  $F = -9649.98$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $As_t = 709.9999$

-Compression:  $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{t,ten} = 709.9999$

-Compression:  $As_{l,com} = 1266.062$

-Middle:  $As_{l,mid} = 402.1239$

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{t,ten,jacket} = 402.1239$

-Compression:  $As_{l,com,jacket} = 804.2477$

-Middle:  $As_{l,mid,jacket} = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{t,ten,core} = 307.8761$

-Compression:  $As_{l,com,core} = 461.8141$

-Middle:  $As_{l,mid,core} = 0.00$

Mean Diameter of Tension Reinforcement,  $Db_L = 15.00$

Existing component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $\phi_{R,u} = \phi_{R,u} = 0.03131369$

$$u = y + p = 0.03479299$$

- Calculation of  $y$  -

$$y = (M_y \cdot L_s / 3) / E_{eff} = 0.00479299 \text{ ((4.29), Biskinis Phd)}$$

$$M_y = 1.8555E+008$$

$$L_s = M/V \text{ (with } L_s > 0.1 \cdot L \text{ and } L_s < 2 \cdot L) = 6000.00$$

$$\text{From table 10.5, ASCE 41_17: } E_{eff} = 0.3 \cdot E_c \cdot I_g = 7.7426E+013$$

Calculation of Yielding Moment  $M_y$

Calculation of  $y$  and  $M_y$  according to Annex 7 -

$$y = \text{Min}(y_{ten}, y_{com})$$

$$y_{ten} = 3.6547586E-006$$

$$\text{with ((10.1), ASCE 41-17) } f_y = \text{Min}(f_y, 1.25 \cdot f_y \cdot (I_b / I_d)^{2/3}) = 372.8122$$

$$d = 627.00$$

$$y = 0.18654435$$

$$A = 0.00958561$$

$$B = 0.00413701$$

$$\text{with } p_t = 0.00283094$$

$$p_c = 0.00504809$$

$$p_v = 0.00160336$$

$$N = 9649.98$$

$$b = 400.00$$

$$" = 0.06858054$$

$$y_{comp} = 1.9009820E-005$$

$$\text{with } f_c = 28.14925$$

$$E_c = 26999.444$$

$$y = 0.18458061$$

$$A = 0.00939495$$

$$B = 0.0040338$$

$$\text{with } E_s = 200000.00$$

Calculation of ratio  $I_b / I_d$

$$\text{Lap Length: } I_d / I_{d,min} = 0.43488144$$

$$I_b = 300.00$$

$$I_d = 689.8432$$

$$\text{Calculation of } I \text{ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.}$$

$$= 1$$

$$d_b = 15.23077$$

$$\text{Mean strength value of all re-bars: } f_y = 516.2752$$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

- Calculation of  $p$  -

From table 10-7:  $p = 0.03$

with:

- Condition iv occurred  
Beam controlled by inadequate embedment into beam-column joint:  
( $I_b / I_d < 1$  and With Lapping in the Vicinity of the End Regions)
- Condition i occurred  
Beam controlled by flexure:  $V_p / V_o \leq 1$   
shear control ratio  $V_p / V_o = 0.49656722$
- Transverse Reinforcement: C

- Stirrup Spacing  $\leq d/3$
- Low ductility demand,  $\lambda / y < 2$  (table 10-6, ASCE 41-17)  
 $= 7.8778516E-005$
- Stirrup Spacing  $\leq d/2$   
 $d = d_{\text{external}} = 627.00$   
 $s = s_{\text{external}} = 150.00$
- Strength provided by hoops  $V_s < 3/4 \cdot \text{design Shear}$   
 $V_s = 371407.964$ , already given in calculation of shear control ratio  
 $\text{design Shear} = 1226.091$
- $(\lambda - y) / \lambda = -0.26284228$   
 $= A_{slt} / (b_w \cdot d) = 0.00283094$   
 Tension Reinf Area:  $A_{slt} = 709.9999$   
 $\lambda = A_{slc} / (b_w \cdot d) = 0.00665146$   
 Compression Reinf Area:  $A_{slc} = 1668.186$
- From (B-1), ACI 318-11:  $\lambda = 0.0145354$   
 $f_c = (f_{c\_jacket} \cdot \text{Area}_{jacket} + f_{c\_core} \cdot \text{Area}_{core}) / \text{section\_area} = 28.14925$   
 $f_y = f_{y\_jacket\_bars} = 555.56$   
 From 10.2.7.3, ACI 318-11:  $\lambda = 0.65$   
 From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000 / (87000 + f_y) = c_b / d_t = 0.003 / (0.003 + y) = 0.51922877$   
 $y = 0.0027778$
- $V / (b_w \cdot d \cdot f_c^{0.5}) = 0.01109647$ , 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)

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## Calculation No. 11

beam B1, Floor 1

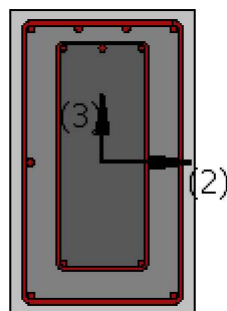
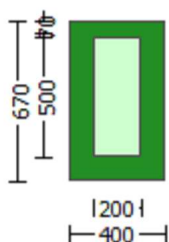
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity  $V_{Rd}$

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcjars

#### Constant Properties

Knowledge Factor,  $\phi = 0.90$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

Existing material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 16.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 400.00$

Concrete Elasticity,  $E_c = 21019.039$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length  $l_o = l_b = 300.00$

No FRP Wrapping

#### Stepwise Properties

EDGE -A-

Bending Moment,  $M_a = 8.9415E+006$

Shear Force,  $V_a = 1226.091$

EDGE -B-

Bending Moment,  $M_b = 1.6903E+007$

Shear Force,  $V_b = 18455.175$

BOTH EDGES

Axial Force,  $F = -9649.98$

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,  $Db_{L,ten} = 15.00$

Existing component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $VR = *V_n = 421136.164$

$V_n$  ((22.5.1.1), ACI 318-14) = 467929.071

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).

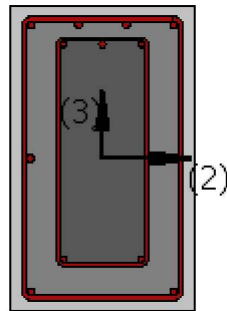
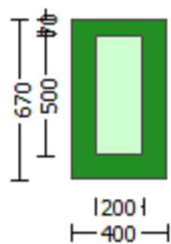
From Table (22.5.5.1), ACI 318-14:  $V_c = 160471.87$

= 1 (normal-weight concrete)  
 Mean concrete strength:  $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 21.64179$ , 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  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / M_u < 1 = 0.07349869$   
 $M_u = 8.9415E+006$   
 $V_u = 1226.091$   
 From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 307457.201$   
 $V_{s1} = 280648.944$  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)  
 $V_{s2} = 26808.257$  is calculated for core, with:  
 $d = 400.00$   
 $A_v = 100530.965$   
 $f_y = 400.00$   
 $s = 300.00$   
 $V_{s2}$  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:  $V_s + V_f \leq 662579.716$

-----  
 End Of Calculation of Shear Capacity for element: beam JB1 of floor 1  
 At local axis: 3  
 Integration Section: (a)

## Calculation No. 12

beam B1, Floor 1  
 Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)  
 Analysis: Uniform +X  
 Check: Chord rotation capacity (  $\phi_r$  )  
 Edge: Start  
 Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor,  $\phi = 0.90$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 20.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 444.44$

Concrete Elasticity,  $E_c = 21019.039$

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

Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 555.55$

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length  $l_o = 300.00$

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,  $F = -2285.866$   
 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,  $V_e/V_r = 0.49656722$   
 Member Controlled by Flexure ( $V_e/V_r < 1$ )  
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 266008.163$   
 with  
 $M_{pr1} = \text{Max}(\mu_{1+}, \mu_{1-}) = 3.8425E+008$   
 $\mu_{1+} = 2.2952E+008$ , 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  
 $\mu_{1-} = 3.8425E+008$ , 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  
 $M_{pr2} = \text{Max}(\mu_{2+}, \mu_{2-}) = 3.8425E+008$   
 $\mu_{2+} = 2.2952E+008$ , 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  
 $\mu_{2-} = 3.8425E+008$ , 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:  
 $\phi_u = 1.2638035E-005$   
 $M_u = 2.2952E+008$

with full section properties:

$b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027619$   
 $N = 2285.866$   
 $f_c = 33.00$   
 $\phi_c (5A.5, \text{TB DY}) = 0.002$   
 Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00512221$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TB DY:  $\phi_u = 0.00512221$   
 $w_e (5.4c) = 0.00164473$   
 $\phi_{se} ((5.4d), \text{TB DY}) = (\phi_{se1} \cdot A_{ext} + \phi_{se2} \cdot A_{int})/A_{sec} = 0.14776895$   
 $\phi_{se1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $\phi_{psh,min} \cdot F_{ywe} = \text{Min}(\phi_{psh,x} \cdot F_{ywe}, \phi_{psh,y} \cdot F_{ywe}) = 1.22434$   
 Expression ((5.4d), TB DY) 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)

$\phi_{psh,x} \cdot F_{ywe} = \phi_{psh1} \cdot F_{ywe1} + \phi_{psh2} \cdot F_{ywe2} = 2.16539$



$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00261799$$

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00062519$$

$$Ash2 = Astir_2 \cdot ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.22434$$

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$$

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$$

$$Ash2 = Astir_2 \cdot ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 555.55$$

$$fce = 33.00$$

$$\text{From } ((5A5), \text{ TBDY}), \text{ TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.00154581$$

$$sh1 = 0.00494661$$

$$ft1 = 470.5847$$

$$fy1 = 392.1539$$

$$su1 = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou, \min = lb/ld = 0.34790516$$

$$su1 = 0.4 \cdot esu1_{\text{nominal}} ((5.5), \text{ TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu1_{\text{nominal}} = 0.08,$$

For calculation of esu1\_nominal and y1, sh1, ft1, fy1, it is considered  
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs1 = (fs_{\text{jacket}} \cdot Asl, \text{ten, jacket} + fs_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 392.1539$$

$$\text{with } Es1 = (Es_{\text{jacket}} \cdot Asl, \text{ten, jacket} + Es_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.00154581$$

$$sh2 = 0.00494661$$

$$ft2 = 477.682$$

$$fy2 = 398.0683$$

$$su2 = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 0.34790516$$

$$su2 = 0.4 \cdot esu2_{\text{nominal}} ((5.5), \text{ TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu2_{\text{nominal}} = 0.08,$$

For calculation of esu2\_nominal and y2, sh2, ft2, fy2, it is considered  
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs2 = (fs_{\text{jacket}} \cdot Asl, \text{com, jacket} + fs_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 398.0683$$

$$\text{with } Es2 = (Es_{\text{jacket}} \cdot Asl, \text{com, jacket} + Es_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.00154581$$

$$shv = 0.00494661$$

$$ftv = 515.2755$$

$$fyv = 429.3962$$

$$suv = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$l_o/l_{ou,min} = l_b/l_d = 0.34790516$   
 $suv = 0.4 * esuv\_nominal ((5.5), TBDY) = 0.032$   
 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  $fsv = (fs\_jacket * Asl\_mid,jacket + fs\_mid * Asl\_mid,core) / Asl\_mid = 429.3962$   
 with  $Esv = (Es\_jacket * Asl\_mid,jacket + Es\_mid * Asl\_mid,core) / Asl\_mid = 200000.00$   
 $1 = Asl\_ten / (b * d) * (fs1 / fc) = 0.03364135$   
 $2 = Asl\_com / (b * d) * (fs2 / fc) = 0.06089352$   
 $v = Asl\_mid / (b * d) * (fsv / fc) = 0.02086299$

and confined core properties:

$b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl\_ten / (b * d) * (fs1 / fc) = 0.0415669$   
 $2 = Asl\_com / (b * d) * (fs2 / fc) = 0.0752394$   
 $v = Asl\_mid / (b * d) * (fsv / fc) = 0.0257781$

Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)

--->  
 $v < vs,y2$  - LHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.1217168$   
 $Mu = MRc (4.14) = 2.2952E+008$   
 $u = su (4.1) = 1.2638035E-005$

Calculation of ratio  $l_b/l_d$

Lap Length:  $l_b/l_d = 0.34790516$   
 $l_b = 300.00$   
 $l_d = 862.304$   
 Calculation of  $l_b,min$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.  
 $= 1$   
 $db = 15.23077$   
 Mean strength value of all re-bars:  $fy = 645.3439$   
 $t = 1.16154$   
 $s = 0.80$   
 $e = 1.00$   
 $cb = 25.00$   
 $Ktr = 2.64216$   
 $n = 13.00$

Calculation of  $Mu1$ -

Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:  
 $u = 1.3095001E-005$   
 $Mu = 3.8425E+008$

with full section properties:

$b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027619$   
 $N = 2285.866$   
 $fc = 33.00$   
 $co (5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00512221$

The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $c_u = 0.00512221$   
 $w_e$  (5.4c) = 0.00164473  
 $a_{se}$  ((5.4d), TBDY) =  $(a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int}) / A_{sec} = 0.14776895$   
 $a_{se1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $p_{sh,min} \cdot F_{ywe} = \text{Min}(p_{sh,x} \cdot F_{ywe}, p_{sh,y} \cdot F_{ywe}) = 1.22434$   
 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)

$p_{sh,x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 2.16539$   
 $p_{s1}$  (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,  $n_{s\_2} = 2.00$   
 $h_2 = 500.00$

$p_{sh,y} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 1.22434$   
 $p_{s1}$  (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,  $n_{s\_2} = 2.00$   
 $h_2 = 200.00$

$A_{sec} = 268000.00$   
 $s_1 = 150.00$   
 $s_2 = 300.00$   
 $f_{ywe1} = 694.45$   
 $f_{ywe2} = 555.55$   
 $f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY:  $c_c = 0.002$   
 $c$  = confinement factor = 1.00

$y_1 = 0.00154581$   
 $sh_1 = 0.00494661$   
 $ft_1 = 477.682$   
 $fy_1 = 398.0683$   
 $su_1 = 0.00695956$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00

$l_o / l_{ou,min} = l_b / l_d = 0.34790516$

$su_1 = 0.4 \cdot esu_{1\_nominal}$  ((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  $fs_1 = (f_{s,jacket} \cdot A_{s,ten,jacket} + f_{s,core} \cdot A_{s,ten,core}) / A_{s,ten} = 398.0683$

with  $Es_1 = (E_{s,jacket} \cdot A_{s,ten,jacket} + E_{s,core} \cdot A_{s,ten,core}) / A_{s,ten} = 200000.00$

$y_2 = 0.00154581$   
 $sh_2 = 0.00494661$   
 $ft_2 = 470.5847$   
 $fy_2 = 392.1539$   
 $su_2 = 0.00695956$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with

```

Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.34790516
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 = 392.1539
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00154581
shv = 0.00494661
ftv = 515.2755
fyv = 429.3962
suv = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.34790516
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 = 429.3962
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06089352
2 = Asl,com/(b*d)*(fs2/fc) = 0.03364135
v = Asl,mid/(b*d)*(fsv/fc) = 0.02086299
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) = 0.0752394
2 = Asl,com/(b*d)*(fs2/fc) = 0.0415669
v = Asl,mid/(b*d)*(fsv/fc) = 0.0257781
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1523656
Mu = MRc (4.14) = 3.8425E+008
u = su (4.1) = 1.3095001E-005

```

#### Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.34790516
lb = 300.00
ld = 862.304
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 645.3439
t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

```

## Calculation of $\mu_{2+}$

Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:

$$\mu = 1.2638035E-005$$

$$\mu = 2.2952E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027619$$

$$N = 2285.866$$

$$f_c = 33.00$$

$$cc(5A.5, TBDY) = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear\_factor} * \text{Max}(\mu, cc) = 0.00512221$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu = 0.00512221$$

$$\mu_e(5.4c) = 0.00164473$$

$$ase((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

$$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.22434$$

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)

$$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.16539$$

$$ps1(\text{external}) = (A_{sh1} * h1 / s1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2(\text{internal}) = (A_{sh2} * h2 / s2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.22434$$

$$ps1(\text{external}) = (A_{sh1} * h1 / s1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2(\text{internal}) = (A_{sh2} * h2 / s2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.00154581$$

$$sh1 = 0.00494661$$

$$ft1 = 470.5847$$

$$fy1 = 392.1539$$

$$su1 = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor

and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00  
 $lo/lou,min = lb/ld = 0.34790516$   
 $su1 = 0.4*esu1\_nominal ((5.5), TBDY) = 0.032$   
From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,  
For calculation of  $esu1\_nominal$  and  $y1, sh1,ft1,fy1$ , it is considered  
characteristic value  $fsy1 = fs1/1.2$ , from table 5.1, TBDY.  
 $y1, sh1,ft1,fy1$ , are also multiplied by  $Min(1,1.25*(lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
with  $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 392.1539$   
with  $Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$   
 $y2 = 0.00154581$   
 $sh2 = 0.00494661$   
 $ft2 = 477.682$   
 $fy2 = 398.0683$   
 $su2 = 0.00695956$   
using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00  
 $lo/lou,min = lb/lb,min = 0.34790516$   
 $su2 = 0.4*esu2\_nominal ((5.5), TBDY) = 0.032$   
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  $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 398.0683$   
with  $Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$   
 $yv = 0.00154581$   
 $shv = 0.00494661$   
 $ftv = 515.2755$   
 $fyv = 429.3962$   
 $suv = 0.00695956$   
using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00  
 $lo/lou,min = lb/ld = 0.34790516$   
 $suv = 0.4*esuv\_nominal ((5.5), TBDY) = 0.032$   
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  $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 429.3962$   
with  $Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$   
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.03364135$   
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.06089352$   
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.02086299$   
and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.0415669$   
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.0752394$   
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.0257781$   
Case/Assumption: Unconfined full section - Steel rupture  
'satisfies Eq. (4.3)  
--->  
 $v < vs,y2$  - LHS eq.(4.5) is satisfied  
--->  
 $su (4.9) = 0.1217168$   
 $Mu = MRc (4.14) = 2.2952E+008$   
 $u = su (4.1) = 1.2638035E-005$

-----  
Calculation of ratio  $lb/ld$

Lap Length:  $l_b/l_d = 0.34790516$

$l_b = 300.00$

$l_d = 862.304$

Calculation of  $l_b$ , min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$= 1$

$db = 15.23077$

Mean strength value of all re-bars:  $f_y = 645.3439$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of  $\mu_2$ -

Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:

$\mu = 1.3095001E-005$

$\mu_u = 3.8425E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.00027619$

$N = 2285.866$

$f_c = 33.00$

$\phi$  (5A.5, TBDY) = 0.002

Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.00512221$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $\phi_u = 0.00512221$

$\phi_{we}$  (5.4c) = 0.00164473

$a_{se}$  ((5.4d), TBDY) =  $(a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o\_1} = 340.00$

$h_{o\_1} = 610.00$

$b_{i2\_1} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o\_2} = 192.00$

$h_{o\_2} = 492.00$

$b_{i2\_2} = 557856.00$

$\phi_{sh,min} * F_{ywe} = \text{Min}(\phi_{sh,x} * F_{ywe}, \phi_{sh,y} * F_{ywe}) = 1.22434$

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)

$\phi_{sh,x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.16539$

$\phi_{sh1}$  (external) =  $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$

No stirrups,  $n_{s\_1} = 2.00$

$h_1 = 670.00$

$\phi_{sh2}$  (internal) =  $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$

$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$

No stirrups,  $n_{s\_2} = 2.00$

$h_2 = 500.00$

$\phi_{sh,y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.22434$

$\phi_{sh1}$  (external) =  $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$

$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$

No stirrups,  $n_{s\_1} = 2.00$

$h_1 = 400.00$

$\phi_{sh2}$  (internal) =  $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$

$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$

No stirrups, ns\_2 = 2.00  
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 555.55

fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00154581

sh1 = 0.00494661

ft1 = 477.682

fy1 = 398.0683

su1 = 0.00695956

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

lo/lou,min = lb/lb = 0.34790516

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 = 398.0683

with Es1 = (Es,jacket\*Asl,ten,jacket + Es,core\*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00154581

sh2 = 0.00494661

ft2 = 470.5847

fy2 = 392.1539

su2 = 0.00695956

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

lo/lou,min = lb/lb,min = 0.34790516

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 = 392.1539

with Es2 = (Es,jacket\*Asl,com,jacket + Es,core\*Asl,com,core)/Asl,com = 200000.00

yv = 0.00154581

shv = 0.00494661

ftv = 515.2755

fyv = 429.3962

suv = 0.00695956

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

lo/lou,min = lb/lb = 0.34790516

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 = 429.3962

with Esv = (Es,jacket\*Asl,mid,jacket + Es,mid\*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.06089352

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.03364135

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.02086299

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00



$f_{cc}$  (5A.2, TBDY) = 33.00  
 $c_c$  (5A.5, TBDY) = 0.002  
 $c$  = confinement factor = 1.00  
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.0752394$   
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.0415669$   
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.0257781$   
 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) = 0.1523656  
 $M_u = M_{Rc}$  (4.14) = 3.8425E+008  
 $u = \mu_u$  (4.1) = 1.3095001E-005

Calculation of ratio  $l_b/l_d$

Lap Length:  $l_b/l_d = 0.34790516$   
 $l_b = 300.00$   
 $l_d = 862.304$   
 Calculation of  $l_b$ ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.  
 $= 1$   
 $db = 15.23077$   
 Mean strength value of all re-bars:  $f_y = 645.3439$   
 $t = 1.16154$   
 $s = 0.80$   
 $e = 1.00$   
 $cb = 25.00$   
 $K_{tr} = 2.64216$   
 $n = 13.00$

Calculation of Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 535694.165$

Calculation of Shear Strength at edge 1,  $V_{r1} = 535694.165$   
 $V_{r1} = V_n$  ((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:  $V_c = 194072.856$   
 $= 1$  (normal-weight concrete)  
 Mean concrete strength:  $f'_c = (f'_{c,jacket} \cdot \text{Area}_{jacket} + f'_{c,core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 28.14925$ , but  $f_c^{0.5} < =$   
 8.3 MPa (22.5.3.1, ACI 318-14)  
 $p_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / M_u < 1 = 1.00$   
 $M_u = 1.1086E+006$   
 $V_u = 9840.632$   
 From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 341621.309$   
 $V_{s1} = 311834.654$  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)  
 $V_{s2} = 29786.655$  is calculated for jacket, with:  
 $d_2 = 400.00$   
 $A_v = 100530.965$   
 $f_y = 444.44$   
 $s = 300.00$   
 $V_{s2}$  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:  $V_s + V_f \leq 755657.47$

Calculation of Shear Strength at edge 2,  $V_{r2} = 535694.165$   
 $V_{r2} = V_n ((22.5.1.1), \text{ACI } 318-14)$

NOTE: In expression (22.5.1.1) ' $V_w$ ' is replaced by ' $V_w + f^*V_f$ '  
where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14:  $V_c = 194072.856$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.14925$ , but  $f'_c^{0.5} \leq 8.3 \text{ MPa}$  (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / M_u < 1 = 1.00$   
 $M_u = 1.1086 \text{E}+006$   
 $V_u = 9840.634$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 341621.309$   
 $V_{s1} = 311834.654$  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)  
 $V_{s2} = 29786.655$  is calculated for jacket, with:  
 $d = 400.00$   
 $A_v = 100530.965$   
 $f_y = 444.44$   
 $s = 300.00$   
 $V_{s2}$  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:  $V_s + V_f \leq 755657.47$

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,  $\phi = 0.90$   
Mean strength values are used for both shear and moment calculations.  
Consequently:  
Jacket  
New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$   
New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$   
Concrete Elasticity,  $E_c = 26999.444$   
Steel Elasticity,  $E_s = 200000.00$   
Existing Column  
Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 20.00$   
Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 444.44$   
Concrete Elasticity,  $E_c = 21019.039$   
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
Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 555.55$ 
#####
External Height,  $H = 670.00$ 
External Width,  $W = 400.00$ 
Internal Height,  $H = 500.00$ 
Internal Width,  $W = 200.00$ 
Cover Thickness,  $c = 25.00$ 
Mean Confinement Factor overall section = 1.00
Element Length,  $L = 3000.00$ 
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length  $l_o = 300.00$ 
No FRP Wrapping
-----

Stepwise Properties
-----
At local axis: 2
EDGE -A-
Shear Force,  $V_a = 4.8511603E-015$ 
EDGE -B-
Shear Force,  $V_b = -4.8511603E-015$ 
BOTH EDGES
Axial Force,  $F = -2285.866$ 
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 ,  $V_e/V_r = 0.30156355$ 
Member Controlled by Flexure ( $V_e/V_r < 1$ )
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 111027.496$ 
with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 1.6654E+008$ 
 $\mu_{u1+} = 1.6654E+008$ , 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
 $\mu_{u1-} = 1.6654E+008$ , 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
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 1.6654E+008$ 
 $\mu_{u2+} = 1.6654E+008$ , 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
 $\mu_{u2-} = 1.6654E+008$ , 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
 $V_1 = 4.8511603E-015$ , is the shear force acting at edge 1 for the the static loading combination
 $V_2 = -4.8511603E-015$ , is the shear force acting at edge 2 for the the static loading combination
-----

Calculation of  $\mu_{u1+}$ 
-----

-----

Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

```

u = 2.2916591E-005  
Mu = 1.6654E+008

with full section properties:

b = 670.00  
d = 357.00  
d' = 43.00  
v = 0.0002896  
N = 2285.866  
fc = 33.00  
co (5A.5, TBDY) = 0.002  
Final value of cu: cu\* = shear\_factor \* Max( cu, cc) = 0.00512221  
The Shear\_factor is considered equal to 1 (pure moment strength)  
From (5.4b), TBDY: cu = 0.00512221  
we (5.4c) = 0.00164473  
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) = 1.22434  
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 = 2.16539  
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 = 1.22434  
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 = 555.55  
fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.002  
c = confinement factor = 1.00  
y1 = 0.00154581  
sh1 = 0.00494661  
ft1 = 480.4475  
fy1 = 400.3729  
su1 = 0.00695956  
using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00  
lo/lou,min = lb/d = 0.34790516  
su1 = 0.4\*esu1\_nominal ((5.5), TBDY) = 0.032  
From table 5A.1, TBDY: esu1\_nominal = 0.08,

For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered characteristic value  $fsy1 = fs1/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25*(lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.  
with  $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 400.3729$   
with  $Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$   
 $y2 = 0.00154581$   
 $sh2 = 0.00494661$   
 $ft2 = 480.4475$   
 $fy2 = 400.3729$   
 $su2 = 0.00695956$   
using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00  
 $lo/lou,min = lb/lb,min = 0.34790516$   
 $su2 = 0.4*esu2\_nominal ((5.5), TBDY) = 0.032$   
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  $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 400.3729$   
with  $Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$   
 $yv = 0.00154581$   
 $shv = 0.00494661$   
 $ftv = 486.7441$   
 $fyv = 405.62$   
 $suv = 0.00695956$   
using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00  
 $lo/lou,min = lb/ld = 0.34790516$   
 $suv = 0.4*esuv\_nominal ((5.5), TBDY) = 0.032$   
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  $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 405.62$   
with  $Es_v = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$   
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.04621209$   
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.04621209$   
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.02857496$

and confined core properties:

$b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.05541419$   
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.05541419$   
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.03426502$

Case/Assumption: Unconfined full section - Steel rupture  
' satisfies Eq. (4.3)

--->  
 $v < vs,y2$  - LHS eq.(4.5) is satisfied  
--->  
 $su (4.9) = 0.14932546$   
 $Mu = MRc (4.14) = 1.6654E+008$   
 $u = su (4.1) = 2.2916591E-005$

Calculation of ratio  $lb/ld$

Lap Length:  $lb/ld = 0.34790516$   
 $lb = 300.00$   
 $ld = 862.304$   
Calculation of  $lb,min$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$\gamma = 1$   
 $db = 15.23077$   
Mean strength value of all re-bars:  $f_y = 645.3439$   
 $t = 1.16154$   
 $s = 0.80$   
 $e = 1.00$   
 $cb = 25.00$   
 $K_{tr} = 2.64216$   
 $n = 13.00$

Calculation of  $\mu_1$ -

Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

$\phi_u = 2.2916591E-005$   
 $\mu = 1.6654E+008$

with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.0002896$   
 $N = 2285.866$   
 $f_c = 33.00$   
 $\alpha_1 (5A.5, TBDY) = 0.002$   
Final value of  $\phi_u$ :  $\phi_u = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.00512221$   
The Shear\_factor is considered equal to 1 (pure moment strength)  
From (5.4b), TBDY:  $\phi_u = 0.00512221$   
 $\phi_{ue} (5.4c) = 0.00164473$   
 $\alpha_{se} ((5.4d), TBDY) = (\alpha_{se1} * A_{ext} + \alpha_{se2} * A_{int}) / A_{sec} = 0.14776895$   
 $\alpha_{se1} = 0.14776895$   
 $b_{o1} = 340.00$   
 $h_{o1} = 610.00$   
 $b_{i21} = 975400.00$   
 $\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.14776895$   
 $b_{o2} = 192.00$   
 $h_{o2} = 492.00$   
 $b_{i22} = 557856.00$   
 $\phi_{sh,min} * F_{ywe} = \text{Min}(\phi_{sh,x} * F_{ywe}, \phi_{sh,y} * F_{ywe}) = 1.22434$   
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)

$\phi_{sh,x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.16539$   
 $\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
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,  $n_{s\_2} = 2.00$   
 $h_2 = 500.00$

$\phi_{sh,y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.22434$   
 $\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
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,  $n_{s\_2} = 2.00$   
 $h_2 = 200.00$

$A_{sec} = 268000.00$   
 $s_1 = 150.00$

```

s2 = 300.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00154581
sh1 = 0.00494661
ft1 = 480.4475
fy1 = 400.3729
su1 = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 0.34790516
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 = 400.3729
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00154581
sh2 = 0.00494661
ft2 = 480.4475
fy2 = 400.3729
su2 = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.34790516
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 = 400.3729
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00154581
shv = 0.00494661
ftv = 486.7441
fyv = 405.62
suv = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 0.34790516
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 = 405.62
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04621209
2 = Asl,com/(b*d)*(fs2/fc) = 0.04621209
v = Asl,mid/(b*d)*(fsv/fc) = 0.02857496
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) = 0.05541419
2 = Asl,com/(b*d)*(fs2/fc) = 0.05541419

```

$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.03426502$   
Case/Assumption: Unconfined full section - Steel rupture  
'satisfies Eq. (4.3)

--->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is satisfied

--->  
 $\mu_u(4.9) = 0.14932546$   
 $\mu_u = M_{Rc}(4.14) = 1.6654E+008$   
 $u = \mu_u(4.1) = 2.2916591E-005$

Calculation of ratio  $l_b/l_d$

Lap Length:  $l_b/l_d = 0.34790516$   
 $l_b = 300.00$   
 $l_d = 862.304$   
Calculation of  $l_b$ ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.  
 $= 1$   
 $d_b = 15.23077$   
Mean strength value of all re-bars:  $f_y = 645.3439$   
 $t = 1.16154$   
 $s = 0.80$   
 $e = 1.00$   
 $c_b = 25.00$   
 $K_{tr} = 2.64216$   
 $n = 13.00$

Calculation of  $\mu_{u2+}$

Calculation of ultimate curvature  $\mu_u$  according to 4.1, Biskinis/Fardis 2013:  
 $u = 2.2916591E-005$   
 $\mu_u = 1.6654E+008$

with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.0002896$   
 $N = 2285.866$   
 $f_c = 33.00$   
 $\phi(5A.5, TBDY) = 0.002$   
Final value of  $\phi_{cu}$ :  $\phi_{cu}^* = \text{shear\_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00512221$   
The Shear\_factor is considered equal to 1 (pure moment strength)  
From (5.4b), TBDY:  $\phi_{cu} = 0.00512221$   
 $\phi_{we}(5.4c) = 0.00164473$   
 $\phi_{ase}((5.4d), TBDY) = (\phi_{ase1} * A_{ext} + \phi_{ase2} * A_{int}) / A_{sec} = 0.14776895$   
 $\phi_{ase1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $\phi_{ase2} = \text{Max}(\phi_{ase1}, \phi_{ase2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $\phi_{psh,min} * F_{ywe} = \text{Min}(\phi_{psh,x} * F_{ywe}, \phi_{psh,y} * F_{ywe}) = 1.22434$   
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)

$\phi_{psh,x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 2.16539$   
 $\phi_{ps1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
No stirrups,  $n_{s\_1} = 2.00$   
 $h_1 = 670.00$



$$ps_2 \text{ (internal)} = (Ash_2 * h_2 / s_2) / A_{sec} = 0.00062519$$

$$Ash_2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h_2 = 500.00$$

$$psh_y * Fy_{we} = psh_1 * Fy_{we1} + ps_2 * Fy_{we2} = 1.22434$$

$$ps_1 \text{ (external)} = (Ash_1 * h_1 / s_1) / A_{sec} = 0.00156298$$

$$Ash_1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h_1 = 400.00$$

$$ps_2 \text{ (internal)} = (Ash_2 * h_2 / s_2) / A_{sec} = 0.00025008$$

$$Ash_2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$fy_{we1} = 694.45$$

$$fy_{we2} = 555.55$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A.5), TBDY), TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.00154581$$

$$sh_1 = 0.00494661$$

$$ft_1 = 480.4475$$

$$fy_1 = 400.3729$$

$$su_1 = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou, \min = lb/ld = 0.34790516$$

$$su_1 = 0.4 * esu_1 \text{ nominal ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu_1 \text{ nominal} = 0.08,$$

For calculation of  $esu_1 \text{ nominal}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered  
characteristic value  $fsy_1 = fs_1 / 1.2$ , from table 5.1, TBDY.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_1 = (fs_{jacket} * A_{sl, \text{ten, jacket}} + fs_{core} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 400.3729$$

$$\text{with } Es_1 = (Es_{jacket} * A_{sl, \text{ten, jacket}} + Es_{core} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 200000.00$$

$$y_2 = 0.00154581$$

$$sh_2 = 0.00494661$$

$$ft_2 = 480.4475$$

$$fy_2 = 400.3729$$

$$su_2 = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 0.34790516$$

$$su_2 = 0.4 * esu_2 \text{ nominal ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu_2 \text{ nominal} = 0.08,$$

For calculation of  $esu_2 \text{ nominal}$  and  $y_2, sh_2, ft_2, fy_2$ , it is considered  
characteristic value  $fsy_2 = fs_2 / 1.2$ , from table 5.1, TBDY.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_2 = (fs_{jacket} * A_{sl, \text{com, jacket}} + fs_{core} * A_{sl, \text{com, core}}) / A_{sl, \text{com}} = 400.3729$$

$$\text{with } Es_2 = (Es_{jacket} * A_{sl, \text{com, jacket}} + Es_{core} * A_{sl, \text{com, core}}) / A_{sl, \text{com}} = 200000.00$$

$$y_v = 0.00154581$$

$$sh_v = 0.00494661$$

$$ft_v = 486.7441$$

$$fy_v = 405.62$$

$$su_v = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou, \min = lb/ld = 0.34790516$$

$$su_v = 0.4 * esu_v \text{ nominal ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu_v \text{ nominal} = 0.08,$$

considering characteristic value  $fsy_v = fs_v / 1.2$ , from table 5.1, TBDY

For calculation of  $e_{suv\_nominal}$  and  $y_v$ ,  $sh_v$ ,  $ft_v$ ,  $fy_v$ , it is considered characteristic value  $f_{sv} = f_{sv}/1.2$ , from table 5.1, TBDY.

$y_1$ ,  $sh_1$ ,  $ft_1$ ,  $fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 405.62$

with  $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.04621209$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.04621209$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02857496$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

$f_{cc} \text{ (5A.2, TBDY)} = 33.00$

$cc \text{ (5A.5, TBDY)} = 0.002$

$c = \text{confinement factor} = 1.00$

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.05541419$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.05541419$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.03426502$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$  - LHS eq.(4.5) is satisfied

--->

$su \text{ (4.9)} = 0.14932546$

$Mu = MR_c \text{ (4.14)} = 1.6654E+008$

$u = su \text{ (4.1)} = 2.2916591E-005$

Calculation of ratio  $l_b/l_d$

Lap Length:  $l_b/l_d = 0.34790516$

$l_b = 300.00$

$l_d = 862.304$

Calculation of  $l_{b,min}$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

= 1

$db = 15.23077$

Mean strength value of all re-bars:  $fy = 645.3439$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of  $Mu_2$ -

Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:

$u = 2.2916591E-005$

$Mu = 1.6654E+008$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.0002896$

$N = 2285.866$

$f_c = 33.00$

$co \text{ (5A.5, TBDY)} = 0.002$

Final value of  $cu$ :  $cu^* = \text{shear\_factor} \cdot \text{Max}(cu, cc) = 0.00512221$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $cu = 0.00512221$

we (5.4c) = 0.00164473

ase ((5.4d), TBDY) =  $(ase_1 \cdot A_{ext} + ase_2 \cdot A_{int}) / A_{sec} = 0.14776895$

```

ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = 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) = 1.22434
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 = 2.16539
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 = 1.22434
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 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00154581
sh1 = 0.00494661
ft1 = 480.4475
fy1 = 400.3729
su1 = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.34790516
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fsjacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 400.3729
with Es1 = (Esjacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00154581
sh2 = 0.00494661
ft2 = 480.4475
fy2 = 400.3729
su2 = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.34790516
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  $Min(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs2 = (fs\_jacket \cdot Asl,com,jacket + fs\_core \cdot Asl,com,core) / Asl,com = 400.3729$

with  $Es2 = (Es\_jacket \cdot Asl,com,jacket + Es\_core \cdot Asl,com,core) / Asl,com = 200000.00$

$yv = 0.00154581$

$shv = 0.00494661$

$ftv = 486.7441$

$fyv = 405.62$

$suv = 0.00695956$

using (30) in Biskinis/Fardis (2013) multiplied with  $shear\_factor$  and also multiplied by the  $shear\_factor$  according to 15.7.1.4, with  $Shear\_factor = 1.00$

$lo/lou,min = lb/ld = 0.34790516$

$suv = 0.4 \cdot esuv\_nominal ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY:  $esuv\_nominal = 0.08$ ,

considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY

For calculation of  $esuv\_nominal$  and  $yv$ ,  $shv, ftv, fyv$ , it is considered characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.

$y1$ ,  $sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fsv = (fs\_jacket \cdot Asl,mid,jacket + fs\_mid \cdot Asl,mid,core) / Asl,mid = 405.62$

with  $Es_v = (Es\_jacket \cdot Asl,mid,jacket + Es\_mid \cdot Asl,mid,core) / Asl,mid = 200000.00$

$1 = Asl,ten / (b \cdot d) \cdot (fs1 / fc) = 0.04621209$

$2 = Asl,com / (b \cdot d) \cdot (fs2 / fc) = 0.04621209$

$v = Asl,mid / (b \cdot d) \cdot (fsv / fc) = 0.02857496$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

$fcc (5A.2, TBDY) = 33.00$

$cc (5A.5, TBDY) = 0.002$

$c = \text{confinement factor} = 1.00$

$1 = Asl,ten / (b \cdot d) \cdot (fs1 / fc) = 0.05541419$

$2 = Asl,com / (b \cdot d) \cdot (fs2 / fc) = 0.05541419$

$v = Asl,mid / (b \cdot d) \cdot (fsv / fc) = 0.03426502$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < vs,y2$  - LHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.14932546$

$Mu = MRc (4.14) = 1.6654E+008$

$u = su (4.1) = 2.2916591E-005$

-----

Calculation of ratio  $lb/ld$

-----

Lap Length:  $lb/ld = 0.34790516$

$lb = 300.00$

$ld = 862.304$

Calculation of  $lb,min$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$= 1$

$db = 15.23077$

Mean strength value of all re-bars:  $fy = 645.3439$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$Ktr = 2.64216$

$n = 13.00$

-----

-----

-----

Calculation of Shear Strength  $Vr = Min(Vr1, Vr2) = 368172.80$

-----

Calculation of Shear Strength at edge 1,  $Vr1 = 368172.80$

$Vr1 = Vn$  ((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:  $Vc = 182002.857$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 28.14925$ , but  $fc'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $pw = As / (bw \cdot d) = 0.00331157$   
As (tension reinf.) = 709.9999  
bw = 670.00  
d = 320.00  
 $Vu \cdot d / Mu < 1 = 0.00$   
Mu = 6.4841010E-012  
Vu = 4.8511603E-015  
From (11.5.4.8), ACI 318-14:  $Vs1 + Vs2 = 186169.943$   
 $Vs1 = 186169.943$  is calculated for jacket, with:  
d = 320.00  
Av = 157079.633  
fy = 555.56  
s = 150.00  
 $Vs1$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $Vs2 = 0.00$  is calculated for jacket, with:  
d2 = 160.00  
Av = 100530.965  
fy = 444.44  
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:  $Vs + Vf \leq 755657.47$

Calculation of Shear Strength at edge 2,  $Vr2 = 368172.80$   
 $Vr2 = Vn$  ((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:  $Vc = 182002.857$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 28.14925$ , but  $fc'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $pw = As / (bw \cdot d) = 0.00331157$   
As (tension reinf.) = 709.9999  
bw = 670.00  
d = 320.00  
 $Vu \cdot d / Mu < 1 = 0.00$   
Mu = 8.0658469E-012  
Vu = 4.8511603E-015  
From (11.5.4.8), ACI 318-14:  $Vs1 + Vs2 = 186169.943$   
 $Vs1 = 186169.943$  is calculated for jacket, with:  
d = 320.00  
Av = 157079.633  
fy = 555.56  
s = 150.00  
 $Vs1$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $Vs2 = 0.00$  is calculated for jacket, with:  
d = 160.00  
Av = 100530.965  
fy = 444.44  
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:  $Vs + Vf \leq 755657.47$

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,  $\gamma = 0.90$

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 20.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 444.44$

Concrete Elasticity,  $E_c = 21019.039$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length  $l_b = 300.00$

No FRP Wrapping

#### Stepwise Properties

Bending Moment,  $M = -2.8888022E-011$

Shear Force,  $V_2 = 8.5432615E-015$

Shear Force,  $V_3 = 1226.091$

Axial Force,  $F = -9649.98$

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,  $Db_L = 15.20$

Existing component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $\phi_{R} = \phi_u = 0.02940626$

$$u = y + p = 0.03267362$$

- Calculation of  $y$  -

$$y = (M_y \cdot L_s / 3) / E_{eff} = 0.00267362 \text{ ((4.29), Biskinis Phd)}$$

$$M_y = 1.3478E+008$$

$$L_s = M/V \text{ (with } L_s > 0.1 \cdot L \text{ and } L_s < 2 \cdot L) = 1500.00$$

$$\text{From table 10.5, ASCE 41_17: } E_{eff} = 0.3 \cdot E_c \cdot I_g = 2.5206E+013$$

Calculation of Yielding Moment  $M_y$

Calculation of  $y$  and  $M_y$  according to Annex 7 -

$$y = \text{Min}(y_{ten}, y_{com})$$

$$y_{ten} = 6.7373176E-006$$

$$\text{with ((10.1), ASCE 41-17) } f_y = \text{Min}(f_y, 1.25 \cdot f_y \cdot (I_b / I_d)^{2/3}) = 372.8122$$

$$d = 357.00$$

$$y = 0.22499433$$

$$A = 0.01005088$$

$$B = 0.00567834$$

$$\text{with } p_t = 0.00380895$$

$$p_c = 0.00380895$$

$$p_v = 0.00232477$$

$$N = 9649.98$$

$$b = 670.00$$

$$" = 0.12044818$$

$$y_{comp} = 2.7583235E-005$$

$$\text{with } f_c = 28.14925$$

$$E_c = 26999.444$$

$$y = 0.22341802$$

$$A = 0.00985097$$

$$B = 0.00557012$$

$$\text{with } E_s = 200000.00$$

Calculation of ratio  $I_b / I_d$

$$\text{Lap Length: } I_d / I_d, \min = 0.43488144$$

$$I_b = 300.00$$

$$I_d = 689.8432$$

$$\text{Calculation of } I \text{ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.}$$

$$= 1$$

$$d_b = 15.23077$$

$$\text{Mean strength value of all re-bars: } f_y = 516.2752$$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

- Calculation of  $p$  -

From table 10-7:  $p = 0.03$

with:

- Condition iv occurred  
Beam controlled by inadequate embedment into beam-column joint:  
( $I_b / I_d < 1$  and With Lapping in the Vicinity of the End Regions)
- Condition i occurred  
Beam controlled by flexure:  $V_p / V_o \leq 1$   
shear control ratio  $V_p / V_o = 0.30156355$
- Transverse Reinforcement: NC

- Stirrup Spacing  $> d/3$
- Low ductility demand,  $\lambda / y < 2$  (table 10-6, ASCE 41-17)  
 $= 4.2781173E-023$
- Stirrup Spacing  $\leq d/2$   
 $d = d_{\text{external}} = 357.00$   
 $s = s_{\text{external}} = 150.00$
- Strength provided by hoops  $V_s < 3/4 \cdot \text{design Shear}$   
 $V_s = 209999.267$ , already given in calculation of shear control ratio  
 $\text{design Shear} = 8.5432615E-015$
- $(\lambda - y) / \lambda = -0.27560034$   
 $= \text{Aslt} / (b_w \cdot d) = 0.00296835$   
 Tension Reinf Area:  $\text{Aslt} = 709.9999$   
 $\lambda = \text{Aslc} / (b_w \cdot d) = 0.00697431$   
 Compression Reinf Area:  $\text{Aslc} = 1668.186$
- From (B-1), ACI 318-11:  $\lambda = 0.0145354$   
 $f_c = (f_{c\_jacket} \cdot \text{Area}_{jacket} + f_{c\_core} \cdot \text{Area}_{core}) / \text{section\_area} = 28.14925$   
 $f_y = f_{y\_jacket\_bars} = 555.56$   
 From 10.2.7.3, ACI 318-11:  $\lambda = 0.65$   
 From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000 / (87000 + f_y) = c_b / d_t = 0.003 / (0.003 + y) = 0.51922877$   
 $y = 0.0027778$
- $V / (b_w \cdot d \cdot f_c^{0.5}) = 8.1071922E-020$ , NOTE: units in lb & in  
 $b_w = 670.00$

-----  
 End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

-----

## Calculation No. 13

beam B1, Floor 1

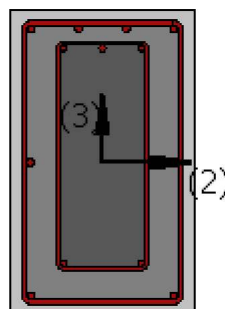
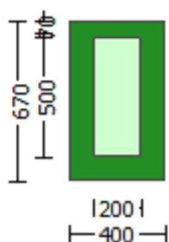
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity  $V_{Rd}$

Edge: End

Local Axis: (2)





Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcjars

#### Constant Properties

Knowledge Factor,  $\phi = 0.90$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$

New material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

Existing material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 16.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 400.00$

Concrete Elasticity,  $E_c = 21019.039$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length  $l_o = l_b = 300.00$

No FRP Wrapping

#### Stepwise Properties

EDGE -A-

Bending Moment,  $M_a = -2.8888022E-011$

Shear Force,  $V_a = 8.5432615E-015$

EDGE -B-

Bending Moment,  $M_b = 5.4215417E-011$

Shear Force,  $V_b = -8.5432615E-015$

BOTH EDGES

Axial Force,  $F = -9649.98$

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:  $As_{l,mid} = 556.0619$

Mean Diameter of Tension Reinforcement,  $Db_{L,ten} = 15.20$

Existing component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $VR = *V_n = 294422.714$

$V_n$  ((22.5.1.1), ACI 318-14) = 327136.349

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:  $V_c = 159584.741$

= 1 (normal-weight concrete)  
 Mean concrete strength:  $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 21.64179$ , but  $fc'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u \cdot d / M_u < 1 = 0.00$   
 $M_u = 5.4215417E-011$   
 $V_u = 8.5432615E-015$   
 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:  
 $d = 160.00$   
 $A_v = 100530.965$   
 $f_y = 400.00$   
 $s = 300.00$   
 $V_{s2}$  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:  $V_s + V_f \leq 662579.716$

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

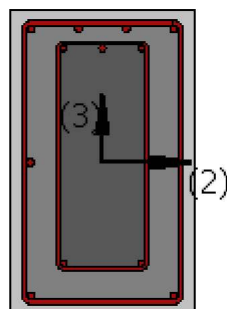
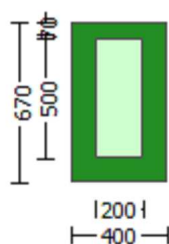
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

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,  $\gamma = 0.90$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 20.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 444.44$

Concrete Elasticity,  $E_c = 21019.039$

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

Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 555.55$

#####

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length  $l_o = 300.00$

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,  $F = -2285.866$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $As_t = 709.9999$

-Compression:  $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{t,ten} = 709.9999$

-Compression:  $As_{l,com} = 1266.062$

-Middle:  $As_{l,mid} = 402.1239$

Calculation of Shear Capacity ratio ,  $V_e/V_r = 0.49656722$

Member Controlled by Flexure ( $V_e/V_r < 1$ )

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 266008.163$   
with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 3.8425E+008$

$M_{u1+} = 2.2952E+008$ , 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

$M_{u1-} = 3.8425E+008$ , 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

$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 3.8425E+008$

$M_{u2+} = 2.2952E+008$ , 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

$M_{u2-} = 3.8425E+008$ , 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  $M_{u1+}$   
-----

-----  
Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

$\phi_u = 1.2638035E-005$

$M_u = 2.2952E+008$   
-----

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.00027619$

$N = 2285.866$

$f_c = 33.00$

$\phi_c$  (5A.5, TBDY) = 0.002

Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00512221$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $\phi_u = 0.00512221$

$\phi_{ue}$  (5.4c) = 0.00164473

$a_{se}$  ((5.4d), TBDY) =  $(a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int})/A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o\_1} = 340.00$

$h_{o\_1} = 610.00$

$b_{i2\_1} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o\_2} = 192.00$

$h_{o\_2} = 492.00$

$b_{i2\_2} = 557856.00$

$\phi_{sh,min} \cdot F_{ywe} = \text{Min}(\phi_{sh,x} \cdot F_{ywe}, \phi_{sh,y} \cdot F_{ywe}) = 1.22434$

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)

-----  
 $\phi_{sh,x} \cdot F_{ywe} = \phi_{sh1} \cdot F_{ywe1} + \phi_{sh2} \cdot F_{ywe2} = 2.16539$

$\phi_{sh1}$  (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,  $n_{s\_1} = 2.00$

$h_1 = 670.00$

$\phi_{sh2}$  (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,  $n_{s\_2} = 2.00$

$h_2 = 500.00$   
-----

$\phi_{sh,y} \cdot F_{ywe} = \phi_{sh1} \cdot F_{ywe1} + \phi_{sh2} \cdot F_{ywe2} = 1.22434$

$\phi_{sh1}$  (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,  $n_{s\_1} = 2.00$

$h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$   
 $Ash2 = Astir\_2 \cdot ns\_2 = 100.531$   
 $No \text{ stirups, } ns\_2 = 2.00$   
 $h2 = 200.00$

$Asec = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$

$fywe1 = 694.45$   
 $fywe2 = 555.55$   
 $fce = 33.00$

From ((5.A5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$

$y1 = 0.00154581$   
 $sh1 = 0.00494661$

$ft1 = 470.5847$

$fy1 = 392.1539$

$su1 = 0.00695956$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $Shear\_factor = 1.00$

$lo/lou,min = lb/ld = 0.34790516$

$su1 = 0.4 \cdot esu1\_nominal \text{ ((5.5), TBDY)} = 0.032$

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  $fs1 = (fs,jacket \cdot Asl,ten,jacket + fs,core \cdot Asl,ten,core) / Asl,ten = 392.1539$

with  $Es1 = (Es,jacket \cdot Asl,ten,jacket + Es,core \cdot Asl,ten,core) / Asl,ten = 200000.00$

$y2 = 0.00154581$

$sh2 = 0.00494661$

$ft2 = 477.682$

$fy2 = 398.0683$

$su2 = 0.00695956$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $Shear\_factor = 1.00$

$lo/lou,min = lb/lb,min = 0.34790516$

$su2 = 0.4 \cdot esu2\_nominal \text{ ((5.5), TBDY)} = 0.032$

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  $fs2 = (fs,jacket \cdot Asl,com,jacket + fs,core \cdot Asl,com,core) / Asl,com = 398.0683$

with  $Es2 = (Es,jacket \cdot Asl,com,jacket + Es,core \cdot Asl,com,core) / Asl,com = 200000.00$

$yv = 0.00154581$

$shv = 0.00494661$

$ftv = 515.2755$

$fyv = 429.3962$

$suv = 0.00695956$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $Shear\_factor = 1.00$

$lo/lou,min = lb/ld = 0.34790516$

$suv = 0.4 \cdot esuv\_nominal \text{ ((5.5), TBDY)} = 0.032$

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  $fsv = (fs,jacket \cdot Asl,mid,jacket + fs,mid \cdot Asl,mid,core) / Asl,mid = 429.3962$

with  $Esu = (Es,jacket \cdot Asl,mid,jacket + Es,mid \cdot Asl,mid,core) / Asl,mid = 200000.00$

$1 = Asl,ten / (b \cdot d) \cdot (fs1 / fc) = 0.03364135$

$2 = Asl,com / (b \cdot d) \cdot (fs2 / fc) = 0.06089352$

$v = Asl,mid / (b \cdot d) \cdot (fsv / fc) = 0.02086299$

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) = 0.0415669
2 = Asl,com/(b*d)*(fs2/fc) = 0.0752394
v = Asl,mid/(b*d)*(fsv/fc) = 0.0257781
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

```

```

--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1217168
Mu = MRc (4.14) = 2.2952E+008
u = su (4.1) = 1.2638035E-005

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.34790516
lb = 300.00
ld = 862.304
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 645.3439
t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

```

Calculation of Mu1-

```

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.3095001E-005
Mu = 3.8425E+008

```

with full section properties:

```

b = 400.00
d = 627.00
d' = 43.00
v = 0.00027619
N = 2285.866
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00512221
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00512221
we (5.4c) = 0.00164473
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) = 1.22434

```

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)

---

$psh_x \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 2.16539$   
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.00261799$   
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$   
 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,  $ns_2 = 2.00$   
 $h2 = 500.00$

---

$psh_y \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 1.22434$   
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.00156298$   
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$   
 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,  $ns_2 = 2.00$   
 $h2 = 200.00$

---

$A_{sec} = 268000.00$

$s1 = 150.00$

$s2 = 300.00$

$fy_{we1} = 694.45$

$fy_{we2} = 555.55$

$f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY:  $cc = 0.002$

$c = \text{confinement factor} = 1.00$

$y1 = 0.00154581$

$sh1 = 0.00494661$

$ft1 = 477.682$

$fy1 = 398.0683$

$su1 = 0.00695956$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$lo/lo_{u,min} = lb/l_d = 0.34790516$

$su1 = 0.4 \cdot esu1_{nominal} \text{ ((5.5), TBDY)} = 0.032$

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  $fs1 = (fs_{jacket} \cdot Asl_{ten,jacket} + fs_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 398.0683$

with  $Es1 = (Es_{jacket} \cdot Asl_{ten,jacket} + Es_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 200000.00$

$y2 = 0.00154581$

$sh2 = 0.00494661$

$ft2 = 470.5847$

$fy2 = 392.1539$

$su2 = 0.00695956$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$lo/lo_{u,min} = lb/l_{b,min} = 0.34790516$

$su2 = 0.4 \cdot esu2_{nominal} \text{ ((5.5), TBDY)} = 0.032$

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  $fs2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 392.1539$

with  $Es2 = (Es_{jacket} \cdot Asl_{com,jacket} + Es_{core} \cdot Asl_{com,core}) / Asl_{com} = 200000.00$

$yv = 0.00154581$

$shv = 0.00494661$

$ftv = 515.2755$

$fyv = 429.3962$

```

suv = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lo,min = lb/ld = 0.34790516
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 = 429.3962
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06089352
2 = Asl,com/(b*d)*(fs2/fc) = 0.03364135
v = Asl,mid/(b*d)*(fsv/fc) = 0.02086299
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) = 0.0752394
2 = Asl,com/(b*d)*(fs2/fc) = 0.0415669
v = Asl,mid/(b*d)*(fsv/fc) = 0.0257781
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1523656
Mu = MRc (4.14) = 3.8425E+008
u = su (4.1) = 1.3095001E-005
-----

Calculation of ratio lb/ld
-----
Lap Length: lb/ld = 0.34790516
lb = 300.00
ld = 862.304
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 645.3439
t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00
-----

Calculation of Mu2+
-----

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.2638035E-005
Mu = 2.2952E+008
-----
with full section properties:
b = 400.00
d = 627.00
d' = 43.00
v = 0.00027619

```



$N = 2285.866$   
 $f_c = 33.00$   
 $\alpha (5A.5, TBDY) = 0.002$   
 Final value of  $\alpha$ :  $\alpha^* = \text{shear\_factor} * \text{Max}(\alpha, \alpha_c) = 0.00512221$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $\alpha = 0.00512221$   
 $w_e (5.4c) = 0.00164473$   
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$   
 $a_{se1} = 0.14776895$   
 $b_{o\_1} = 340.00$   
 $h_{o\_1} = 610.00$   
 $b_{i2\_1} = 975400.00$   
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$   
 $b_{o\_2} = 192.00$   
 $h_{o\_2} = 492.00$   
 $b_{i2\_2} = 557856.00$   
 $p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.22434$   
 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)

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.16539$   
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 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,  $n_{s\_2} = 2.00$   
 $h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.22434$   
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$   
 $A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$   
 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,  $n_{s\_2} = 2.00$   
 $h_2 = 200.00$

$A_{sec} = 268000.00$   
 $s_1 = 150.00$   
 $s_2 = 300.00$   
 $f_{ywe1} = 694.45$   
 $f_{ywe2} = 555.55$   
 $f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY:  $\alpha_c = 0.002$   
 $\alpha = \text{confinement factor} = 1.00$

$y_1 = 0.00154581$   
 $sh_1 = 0.00494661$   
 $ft_1 = 470.5847$   
 $fy_1 = 392.1539$   
 $su_1 = 0.00695956$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$

$l_o / l_{ou, \min} = l_b / l_d = 0.34790516$

$su_1 = 0.4 * esu_{1, \text{nominal}} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY:  $esu_{1, \text{nominal}} = 0.08$ ,

For calculation of  $esu_{1, \text{nominal}}$  and  $y_1, sh_1, ft_1, fy_1$ , it is considered  
 characteristic value  $fsy_1 = fs_1 / 1.2$ , from table 5.1, TBDY.

$y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.

with  $fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 392.1539$

with  $Es_1 = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$

$y_2 = 0.00154581$   
 $sh_2 = 0.00494661$   
 $ft_2 = 477.682$

```

fy2 = 398.0683
su2 = 0.00695956
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.34790516
    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 = 398.0683
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
    yv = 0.00154581
    shv = 0.00494661
ftv = 515.2755
fyv = 429.3962
suv = 0.00695956
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.34790516
    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 = 429.3962
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.03364135
    2 = Asl,com/(b*d)*(fs2/fc) = 0.06089352
    v = Asl,mid/(b*d)*(fsv/fc) = 0.02086299
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) = 0.0415669
    2 = Asl,com/(b*d)*(fs2/fc) = 0.0752394
    v = Asl,mid/(b*d)*(fsv/fc) = 0.0257781

```

Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)

```

--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1217168
Mu = MRc (4.14) = 2.2952E+008
u = su (4.1) = 1.2638035E-005

```

---

Calculation of ratio lb/ld

---

```

Lap Length: lb/ld = 0.34790516
lb = 300.00
ld = 862.304
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 645.3439
t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216

```

$$n = 13.00$$

Calculation of Mu2-

Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:

$$\mu = 1.3095001E-005$$

$$Mu = 3.8425E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027619$$

$$N = 2285.866$$

$$f_c = 33.00$$

$$cc \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear\_factor} * \text{Max}(\mu, cc) = 0.00512221$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu = 0.00512221$$

$$\mu_e \text{ (5.4c)} = 0.00164473$$

$$ase \text{ ((5.4d), TBDY)} = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo\_1 = 340.00$$

$$ho\_1 = 610.00$$

$$bi2\_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo\_2 = 192.00$$

$$ho\_2 = 492.00$$

$$bi2\_2 = 557856.00$$

$$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.22434$$

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)

$$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.16539$$

$$ps1 \text{ (external)} = (Ash1 * h1 / s1) / A_{sec} = 0.00261799$$

$$Ash1 = Astir\_1 * ns\_1 = 157.0796$$

$$\text{No stirrups, } ns\_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (Ash2 * h2 / s2) / A_{sec} = 0.00062519$$

$$Ash2 = Astir\_2 * ns\_2 = 100.531$$

$$\text{No stirrups, } ns\_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.22434$$

$$ps1 \text{ (external)} = (Ash1 * h1 / s1) / A_{sec} = 0.00156298$$

$$Ash1 = Astir\_1 * ns\_1 = 157.0796$$

$$\text{No stirrups, } ns\_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 * h2 / s2) / A_{sec} = 0.00025008$$

$$Ash2 = Astir\_2 * ns\_2 = 100.531$$

$$\text{No stirrups, } ns\_2 = 2.00$$

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fy_{we1} = 694.45$$

$$fy_{we2} = 555.55$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.00154581$$

$$sh1 = 0.00494661$$

```

ft1 = 477.682
fy1 = 398.0683
su1 = 0.00695956
    using (30) in Biskinis/Fardis (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 = 0.34790516
    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 = 398.0683
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00154581
sh2 = 0.00494661
ft2 = 470.5847
fy2 = 392.1539
su2 = 0.00695956
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb,min = 0.34790516
    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 = 392.1539
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00154581
shv = 0.00494661
ftv = 515.2755
fyv = 429.3962
suv = 0.00695956
    using (30) in Biskinis/Fardis (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 = 0.34790516
    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 = 429.3962
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06089352
2 = Asl,com/(b*d)*(fs2/fc) = 0.03364135
v = Asl,mid/(b*d)*(fsv/fc) = 0.02086299
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) = 0.0752394
    2 = Asl,com/(b*d)*(fs2/fc) = 0.0415669
    v = Asl,mid/(b*d)*(fsv/fc) = 0.0257781
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1523656
Mu = MRc (4.14) = 3.8425E+008

```

$$u = s_u(4.1) = 1.3095001E-005$$

Calculation of ratio  $l_b/d$

Lap Length:  $l_b/d = 0.34790516$

$l_b = 300.00$

$d = 862.304$

Calculation of  $l_b$ , min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$= 1$

$d_b = 15.23077$

Mean strength value of all re-bars:  $f_y = 645.3439$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$c_b = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 535694.165$

Calculation of Shear Strength at edge 1,  $V_{r1} = 535694.165$

$V_{r1} = V_n$  ((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:  $V_c = 194072.856$

$= 1$  (normal-weight concrete)

Mean concrete strength:  $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.14925$ , but  $f'_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$p_w = A_s / (b_w \cdot d) = 0.00331157$

$A_s$  (tension reinf.) = 709.9999

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / M_u < 1 = 1.00$

$M_u = 1.1086E+006$

$V_u = 9840.632$

From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 341621.309$

$V_{s1} = 311834.654$  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)

$V_{s2} = 29786.655$  is calculated for jacket, with:

$d_2 = 400.00$

$A_v = 100530.965$

$f_y = 444.44$

$s = 300.00$

$V_{s2}$  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:  $V_s + V_f \leq 755657.47$

Calculation of Shear Strength at edge 2,  $V_{r2} = 535694.165$

$V_{r2} = V_n$  ((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:  $V_c = 194072.856$

$= 1$  (normal-weight concrete)

Mean concrete strength:  $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.14925$ , but  $f'_c^{0.5} \leq$

8.3 MPa (22.5.3.1, ACI 318-14)  
 $p_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / \mu_u < 1 = 1.00$   
 $\mu_u = 1.1086E+006$   
 $V_u = 9840.634$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 341621.309$   
 $V_{s1} = 311834.654$  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)  
 $V_{s2} = 29786.655$  is calculated for jacket, with:  
 $d = 400.00$   
 $A_v = 100530.965$   
 $f_y = 444.44$   
 $s = 300.00$   
 $V_{s2}$  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:  $V_s + V_f \leq 755657.47$

-----  
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,  $\phi = 0.90$   
Mean strength values are used for both shear and moment calculations.  
Consequently:  
Jacket  
New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$   
New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$   
Concrete Elasticity,  $E_c = 26999.444$   
Steel Elasticity,  $E_s = 200000.00$   
Existing Column  
Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 20.00$   
Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 444.44$   
Concrete Elasticity,  $E_c = 21019.039$   
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  
Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 555.55$   
#####  
External Height,  $H = 670.00$   
External Width,  $W = 400.00$   
Internal Height,  $H = 500.00$   
Internal Width,  $W = 200.00$   
Cover Thickness,  $c = 25.00$   
Mean Confinement Factor overall section = 1.00  
Element Length,  $L = 3000.00$   
Primary Member

Ribbed Bars  
Ductile Steel  
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)  
Longitudinal Bars With Ends Lapped Starting at the End Sections  
Lap Length  $l_o = 300.00$   
No FRP Wrapping

#### Stepwise Properties

At local axis: 2  
EDGE -A-  
Shear Force,  $V_a = 4.8511603E-015$   
EDGE -B-  
Shear Force,  $V_b = -4.8511603E-015$   
BOTH EDGES  
Axial Force,  $F = -2285.866$   
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,  $V_e/V_r = 0.30156355$   
Member Controlled by Flexure ( $V_e/V_r < 1$ )  
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 111027.496$   
with  
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 1.6654E+008$   
 $\mu_{u1+} = 1.6654E+008$ , 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  
 $\mu_{u1-} = 1.6654E+008$ , 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  
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 1.6654E+008$   
 $\mu_{u2+} = 1.6654E+008$ , 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  
 $\mu_{u2-} = 1.6654E+008$ , 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  
 $V_1 = 4.8511603E-015$ , is the shear force acting at edge 1 for the the static loading combination  
 $V_2 = -4.8511603E-015$ , is the shear force acting at edge 2 for the the static loading combination

#### Calculation of $\mu_{u1+}$

Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:  
 $\phi_u = 2.2916591E-005$   
 $\mu_u = 1.6654E+008$

with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.0002896$   
 $N = 2285.866$   
 $f_c = 33.00$   
 $\phi_{co} (5A.5, TBDY) = 0.002$   
Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} * \max(\phi_u, \phi_{co}) = 0.00512221$   
The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $cu = 0.00512221$   
 $we$  (5.4c) = 0.00164473  
 $ase$  ((5.4d), TBDY) =  $(ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo\_1 = 340.00$   
 $ho\_1 = 610.00$   
 $bi2\_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$   
 $psh, \min \cdot F_{ywe} = \text{Min}(psh, x \cdot F_{ywe}, psh, y \cdot F_{ywe}) = 1.22434$   
 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)

$psh, x \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 2.16539$   
 $ps1$  (external) =  $(Ash1 \cdot h1 / s1) / A_{sec} = 0.00261799$   
 $Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$   
 No stirrups,  $ns\_1 = 2.00$   
 $h1 = 670.00$   
 $ps2$  (internal) =  $(Ash2 \cdot h2 / s2) / A_{sec} = 0.00062519$   
 $Ash2 = Astir\_2 \cdot ns\_2 = 100.531$   
 No stirrups,  $ns\_2 = 2.00$   
 $h2 = 500.00$

$psh, y \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 1.22434$   
 $ps1$  (external) =  $(Ash1 \cdot h1 / s1) / A_{sec} = 0.00156298$   
 $Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$   
 No stirrups,  $ns\_1 = 2.00$   
 $h1 = 400.00$   
 $ps2$  (internal) =  $(Ash2 \cdot h2 / s2) / A_{sec} = 0.00025008$   
 $Ash2 = Astir\_2 \cdot ns\_2 = 100.531$   
 No stirrups,  $ns\_2 = 2.00$   
 $h2 = 200.00$

$A_{sec} = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fywe1 = 694.45$   
 $fywe2 = 555.55$   
 $fce = 33.00$

From ((5.A5), TBDY), TBDY:  $cc = 0.002$   
 $c$  = confinement factor = 1.00

$y1 = 0.00154581$   
 $sh1 = 0.00494661$   
 $ft1 = 480.4475$   
 $fy1 = 400.3729$   
 $su1 = 0.00695956$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00

$lo/lou, \min = lb/ld = 0.34790516$

$su1 = 0.4 \cdot esu1\_nominal$  ((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  $fs1 = (fs, \text{jacket} \cdot A_{sl, \text{ten, jacket}} + fs, \text{core} \cdot A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 400.3729$

with  $Es1 = (Es, \text{jacket} \cdot A_{sl, \text{ten, jacket}} + Es, \text{core} \cdot A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 200000.00$

$y2 = 0.00154581$   
 $sh2 = 0.00494661$   
 $ft2 = 480.4475$   
 $fy2 = 400.3729$   
 $su2 = 0.00695956$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00



$l_o/l_{o,min} = l_b/l_{b,min} = 0.34790516$   
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$   
 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  $fs_2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 400.3729$   
 with  $Es_2 = (Es_{jacket} \cdot Asl_{com,jacket} + Es_{core} \cdot Asl_{com,core}) / Asl_{com} = 200000.00$   
 $y_v = 0.00154581$   
 $sh_v = 0.00494661$   
 $ft_v = 486.7441$   
 $fy_v = 405.62$   
 $suv = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $l_o/l_{o,min} = l_b/l_d = 0.34790516$   
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08$ ,  
 considering characteristic value  $fsv = fs_v/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $fsv = fs_v/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.  
 with  $fs_v = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 405.62$   
 with  $Es_v = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$   
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.04621209$   
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.04621209$   
 $v = Asl_{mid} / (b \cdot d) \cdot (fs_v / fc) = 0.02857496$

and confined core properties:

$b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.05541419$   
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.05541419$   
 $v = Asl_{mid} / (b \cdot d) \cdot (fs_v / fc) = 0.03426502$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

$v < v_{s,y2}$  - LHS eq.(4.5) is satisfied

---->

$su (4.9) = 0.14932546$

$Mu = MRc (4.14) = 1.6654E+008$

$u = su (4.1) = 2.2916591E-005$

-----  
 Calculation of ratio  $l_b/l_d$   
 -----

Lap Length:  $l_b/l_d = 0.34790516$

$l_b = 300.00$

$l_d = 862.304$

Calculation of  $l_{b,min}$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

= 1

$db = 15.23077$

Mean strength value of all re-bars:  $fy = 645.3439$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$   
 -----  
 -----  
 -----

Calculation of  $Mu_1$ -

Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

$$u = 2.2916591E-005$$

$$\mu = 1.6654E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0002896$$

$$N = 2285.866$$

$$f_c = 33.00$$

$$\phi_{co} (5A.5, TBDY) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_{co}) = 0.00512221$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.00512221$$

$$\phi_{we} (5.4c) = 0.00164473$$

$$\phi_{ase} ((5.4d), TBDY) = (\phi_{ase1} * A_{ext} + \phi_{ase2} * A_{int}) / A_{sec} = 0.14776895$$

$$\phi_{ase1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

$$\phi_{ase2} = \text{Max}(\phi_{ase1}, \phi_{ase2}) = 0.14776895$$

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

$$\phi_{psh,min} * F_{ywe} = \text{Min}(\phi_{psh,x} * F_{ywe}, \phi_{psh,y} * F_{ywe}) = 1.22434$$

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)

$$\phi_{psh,x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 2.16539$$

$$\phi_{psh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{psh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{psh,y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 1.22434$$

$$\phi_{psh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{psh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_{cc} = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.00154581$$

$$sh_1 = 0.00494661$$

$$ft_1 = 480.4475$$

$$fy_1 = 400.3729$$

$$su_1 = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with

```

Shear_factor = 1.00
lo/lou,min = lb/ld = 0.34790516
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 400.3729
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00154581
sh2 = 0.00494661
ft2 = 480.4475
fy2 = 400.3729
su2 = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.34790516
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 = 400.3729
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00154581
shv = 0.00494661
ftv = 486.7441
fyv = 405.62
suv = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.34790516
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 = 405.62
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04621209
2 = Asl,com/(b*d)*(fs2/fc) = 0.04621209
v = Asl,mid/(b*d)*(fsv/fc) = 0.02857496
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) = 0.05541419
2 = Asl,com/(b*d)*(fs2/fc) = 0.05541419
v = Asl,mid/(b*d)*(fsv/fc) = 0.03426502
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vsy2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.14932546
Mu = MRc (4.14) = 1.6654E+008
u = su (4.1) = 2.2916591E-005

```

Calculation of ratio lb/ld

Lap Length:  $l_b/l_d = 0.34790516$

$l_b = 300.00$

$l_d = 862.304$

Calculation of  $l_b$ , min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.  
 $= 1$

$db = 15.23077$

Mean strength value of all re-bars:  $f_y = 645.3439$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of  $\mu_{2+}$

Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:

$\mu = 2.2916591E-005$

$\mu_u = 1.6654E+008$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.0002896$

$N = 2285.866$

$f_c = 33.00$

$\phi$  (5A.5, TBDY) = 0.002

Final value of  $\mu_u$ :  $\mu_u^* = \text{shear\_factor} * \text{Max}(\mu_u, \mu_c) = 0.00512221$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $\mu_u = 0.00512221$

$\mu_{ue}$  (5.4c) = 0.00164473

$a_{se}$  ((5.4d), TBDY) =  $(a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o\_1} = 340.00$

$h_{o\_1} = 610.00$

$b_{i2\_1} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o\_2} = 192.00$

$h_{o\_2} = 492.00$

$b_{i2\_2} = 557856.00$

$\mu_{sh,min} * F_{ywe} = \text{Min}(\mu_{sh,x} * F_{ywe}, \mu_{sh,y} * F_{ywe}) = 1.22434$

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)

$\mu_{sh,x} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 2.16539$

$\mu_{sh1}$  (external) =  $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$

No stirrups,  $n_{s\_1} = 2.00$

$h_1 = 670.00$

$\mu_{sh2}$  (internal) =  $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$

$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$

No stirrups,  $n_{s\_2} = 2.00$

$h_2 = 500.00$

$\mu_{sh,y} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 1.22434$

$\mu_{sh1}$  (external) =  $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$

$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$

No stirrups,  $n_{s\_1} = 2.00$

$h_1 = 400.00$

$\mu_{sh2}$  (internal) =  $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$

$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$

No stirrups,  $n_{s\_2} = 2.00$

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

$$\text{From } ((5A5), \text{TB DY}), \text{TB DY: } c c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.00154581$$

$$sh1 = 0.00494661$$

$$ft1 = 480.4475$$

$$fy1 = 400.3729$$

$$su1 = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou, \min = lb/ld = 0.34790516$$

$$su1 = 0.4 * esu1\_nominal ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu1\_nominal = 0.08,$$

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.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs1 = (fs\_jacket * Asl, \text{ten, jacket} + fs\_core * Asl, \text{ten, core}) / Asl, \text{ten} = 400.3729$$

$$\text{with } Es1 = (Es\_jacket * Asl, \text{ten, jacket} + Es\_core * Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.00154581$$

$$sh2 = 0.00494661$$

$$ft2 = 480.4475$$

$$fy2 = 400.3729$$

$$su2 = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 0.34790516$$

$$su2 = 0.4 * esu2\_nominal ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu2\_nominal = 0.08,$$

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.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs2 = (fs\_jacket * Asl, \text{com, jacket} + fs\_core * Asl, \text{com, core}) / Asl, \text{com} = 400.3729$$

$$\text{with } Es2 = (Es\_jacket * Asl, \text{com, jacket} + Es\_core * Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.00154581$$

$$shv = 0.00494661$$

$$ftv = 486.7441$$

$$fyv = 405.62$$

$$suv = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou, \min = lb/ld = 0.34790516$$

$$suv = 0.4 * esuv\_nominal ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esuv\_nominal = 0.08,$$

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.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fsv = (fs\_jacket * Asl, \text{mid, jacket} + fs\_mid * Asl, \text{mid, core}) / Asl, \text{mid} = 405.62$$

$$\text{with } Esv = (Es\_jacket * Asl, \text{mid, jacket} + Es\_mid * Asl, \text{mid, core}) / Asl, \text{mid} = 200000.00$$

$$1 = Asl, \text{ten} / (b * d) * (fs1 / f_{ce}) = 0.04621209$$

$$2 = Asl, \text{com} / (b * d) * (fs2 / f_{ce}) = 0.04621209$$

$$v = Asl, \text{mid} / (b * d) * (fsv / f_{ce}) = 0.02857496$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, \text{TB DY}) = 33.00$$

```

cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05541419
2 = Asl,com/(b*d)*(fs2/fc) = 0.05541419
v = Asl,mid/(b*d)*(fsv/fc) = 0.03426502
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.14932546
Mu = MRc (4.14) = 1.6654E+008
u = su (4.1) = 2.2916591E-005

```

#### Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.34790516
lb = 300.00
ld = 862.304
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 645.3439
t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

```

#### Calculation of Mu2-

```

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 2.2916591E-005
Mu = 1.6654E+008

```

#### with full section properties:

```

b = 670.00
d = 357.00
d' = 43.00
v = 0.0002896
N = 2285.866
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00512221
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00512221
we (5.4c) = 0.00164473
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) = 1.22434
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 = 2.16539

```

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00261799$$

$$Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$$

$$\text{No stirups, } ns\_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00062519$$

$$Ash2 = Astir\_2 \cdot ns\_2 = 100.531$$

$$\text{No stirups, } ns\_2 = 2.00$$

$$h2 = 500.00$$

$$psh\_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.22434$$

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$$

$$Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$$

$$\text{No stirups, } ns\_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$$

$$Ash2 = Astir\_2 \cdot ns\_2 = 100.531$$

$$\text{No stirups, } ns\_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 555.55$$

$$fce = 33.00$$

$$\text{From } ((5A5), \text{ TBDY}), \text{ TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.00154581$$

$$sh1 = 0.00494661$$

$$ft1 = 480.4475$$

$$fy1 = 400.3729$$

$$su1 = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou, \min = lb/ld = 0.34790516$$

$$su1 = 0.4 \cdot esu1\_nominal \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu1\_nominal = 0.08,$$

For calculation of esu1\_nominal and y1, sh1, ft1, fy1, it is considered  
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs1 = (fs\_jacket \cdot Asl, \text{ten, jacket} + fs\_core \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 400.3729$$

$$\text{with } Es1 = (Es\_jacket \cdot Asl, \text{ten, jacket} + Es\_core \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.00154581$$

$$sh2 = 0.00494661$$

$$ft2 = 480.4475$$

$$fy2 = 400.3729$$

$$su2 = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 0.34790516$$

$$su2 = 0.4 \cdot esu2\_nominal \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu2\_nominal = 0.08,$$

For calculation of esu2\_nominal and y2, sh2, ft2, fy2, it is considered  
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs2 = (fs\_jacket \cdot Asl, \text{com, jacket} + fs\_core \cdot Asl, \text{com, core}) / Asl, \text{com} = 400.3729$$

$$\text{with } Es2 = (Es\_jacket \cdot Asl, \text{com, jacket} + Es\_core \cdot Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.00154581$$

$$shv = 0.00494661$$

$$ftv = 486.7441$$

$$fyv = 405.62$$

$$suv = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$l_o/l_{ou,min} = l_b/l_d = 0.34790516$   
 $suv = 0.4 * esuv\_nominal ((5.5), TBDY) = 0.032$   
 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  $fsv = (fs\_jacket * Asl\_mid\_jacket + fs\_mid * Asl\_mid\_core) / Asl\_mid = 405.62$   
 with  $Esv = (Es\_jacket * Asl\_mid\_jacket + Es\_mid * Asl\_mid\_core) / Asl\_mid = 200000.00$   
 $1 = Asl\_ten / (b * d) * (fs1 / fc) = 0.04621209$   
 $2 = Asl\_com / (b * d) * (fs2 / fc) = 0.04621209$   
 $v = Asl\_mid / (b * d) * (fsv / fc) = 0.02857496$

and confined core properties:

$b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl\_ten / (b * d) * (fs1 / fc) = 0.05541419$   
 $2 = Asl\_com / (b * d) * (fs2 / fc) = 0.05541419$   
 $v = Asl\_mid / (b * d) * (fsv / fc) = 0.03426502$

Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)

--->

$v < vs,y2$  - LHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.14932546$   
 $Mu = MRc (4.14) = 1.6654E+008$   
 $u = su (4.1) = 2.2916591E-005$

Calculation of ratio  $l_b/l_d$

Lap Length:  $l_b/l_d = 0.34790516$

$l_b = 300.00$

$l_d = 862.304$

Calculation of  $l_b,min$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.  
 $= 1$

$db = 15.23077$

Mean strength value of all re-bars:  $fy = 645.3439$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$Ktr = 2.64216$

$n = 13.00$

Calculation of Shear Strength  $V_r = Min(Vr1, Vr2) = 368172.80$

Calculation of Shear Strength at edge 1,  $Vr1 = 368172.80$

$Vr1 = Vn ((22.5.1.1), ACI 318-14)$

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:  $Vc = 182002.857$   
 $= 1$  (normal-weight concrete)

Mean concrete strength:  $fc' = (fc\_jacket * Area\_jacket + fc\_core * Area\_core) / Area\_section = 28.14925$ , but  $fc'^{0.5} < = 8.3$  MPa (22.5.3.1, ACI 318-14)

$pw = As / (bw * d) = 0.00331157$

$As$  (tension reinf.) = 709.9999

$bw = 670.00$

$d = 320.00$



$$V_u \cdot d / \mu < 1 = 0.00$$

$$\mu = 6.4841010E-012$$

$$V_u = 4.8511603E-015$$

From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$

$V_{s1} = 186169.943$  is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

$V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

$V_{s2} = 0.00$  is calculated for jacket, with:

$$d_2 = 160.00$$

$$A_v = 100530.965$$

$$f_y = 444.44$$

$$s = 300.00$$

$V_{s2}$  is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

$$V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$$

$$\text{From } (11-11), \text{ACI } 440: V_s + V_f \leq 755657.47$$

Calculation of Shear Strength at edge 2,  $V_{r2} = 368172.80$

$$V_{r2} = V_n ((22.5.1.1), \text{ACI } 318-14)$$

NOTE: In expression (22.5.1.1) ' $V_w$ ' is replaced by ' $V_w + f \cdot V_f$ ' where  $V_f$  is the contribution of FRPs (11.3), ACI 440).

$$\text{From Table } (22.5.5.1), \text{ACI } 318-14: V_c = 182002.857$$

= 1 (normal-weight concrete)

$$\text{Mean concrete strength: } f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.14925, \text{ but } f'_c^{0.5} \leq 8.3 \text{ MPa } (22.5.3.1, \text{ACI } 318-14)$$

$$p_w = A_s / (b_w \cdot d) = 0.00331157$$

$$A_s (\text{tension reinf.}) = 709.9999$$

$$b_w = 670.00$$

$$d = 320.00$$

$$V_u \cdot d / \mu < 1 = 0.00$$

$$\mu = 8.0658469E-012$$

$$V_u = 4.8511603E-015$$

From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$

$V_{s1} = 186169.943$  is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

$V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

$V_{s2} = 0.00$  is calculated for jacket, with:

$$d = 160.00$$

$$A_v = 100530.965$$

$$f_y = 444.44$$

$$s = 300.00$$

$V_{s2}$  is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

$$V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$$

$$\text{From } (11-11), \text{ACI } 440: V_s + V_f \leq 755657.47$$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor, = 0.90

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$

Concrete Elasticity,  $E_c = 26999.444$

Steel Elasticity,  $E_s = 200000.00$

Existing Column

Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 20.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 444.44$

Concrete Elasticity,  $E_c = 21019.039$

Steel Elasticity,  $E_s = 200000.00$

External Height,  $H = 670.00$

External Width,  $W = 400.00$

Internal Height,  $H = 500.00$

Internal Width,  $W = 200.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length  $l_b = 300.00$

No FRP Wrapping

#### Stepwise Properties

Bending Moment,  $M = 1.6903E+007$

Shear Force,  $V_2 = -8.5432615E-015$

Shear Force,  $V_3 = 18455.175$

Axial Force,  $F = -9649.98$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $As_t = 709.9999$

-Compression:  $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{t,ten} = 709.9999$

-Compression:  $As_{l,com} = 1266.062$

-Middle:  $As_{l,mid} = 402.1239$

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{t,ten,jacket} = 402.1239$

-Compression:  $As_{l,com,jacket} = 804.2477$

-Middle:  $As_{l,mid,jacket} = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{t,ten,core} = 307.8761$

-Compression:  $As_{l,com,core} = 461.8141$

-Middle:  $As_{l,mid,core} = 0.00$

Mean Diameter of Tension Reinforcement,  $Db_L = 15.00$

Existing component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u_R = * u = 0.02765848$

$u = y + p = 0.03073164$

- Calculation of  $y$  -

$y = (M_y * L_s / 3) / E_{eff} = 0.00073164$  ((4.29), Biskinis Phd))

$M_y = 1.8555E+008$

$L_s = M/V$  (with  $L_s > 0.1 * L$  and  $L_s < 2 * L$ ) = 915.8861

From table 10.5, ASCE 41\_17:  $E_{eff} = 0.3 * E_c * I_g = 7.7426E+013$

Calculation of Yielding Moment  $M_y$

Calculation of  $\gamma$  and  $M_y$  according to Annex 7 -

```
y = Min(  $\gamma_{ten}$ ,  $\gamma_{com}$ )
 $\gamma_{ten} = 3.6547586E-006$ 
with ((10.1), ASCE 41-17)  $f_y = \text{Min}(f_y, 1.25*f_y*(l_b/d)^{2/3}) = 372.8122$ 
d = 627.00
 $\gamma = 0.18654435$ 
A = 0.00958561
B = 0.00413701
with  $p_t = 0.00283094$ 
 $p_c = 0.00504809$ 
 $p_v = 0.00160336$ 
N = 9649.98
b = 400.00
" = 0.06858054
 $\gamma_{comp} = 1.9009820E-005$ 
with  $f_c = 28.14925$ 
 $E_c = 26999.444$ 
 $\gamma = 0.18458061$ 
A = 0.00939495
B = 0.0040338
with  $E_s = 200000.00$ 
```

Calculation of ratio  $l_b/d$

```
Lap Length:  $l_d/l_d, \text{min} = 0.43488144$ 
 $l_b = 300.00$ 
 $l_d = 689.8432$ 
Calculation of I according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 15.23077
Mean strength value of all re-bars:  $f_y = 516.2752$ 
t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00
```

- Calculation of  $p$  -

From table 10-7:  $p = 0.03$

with:

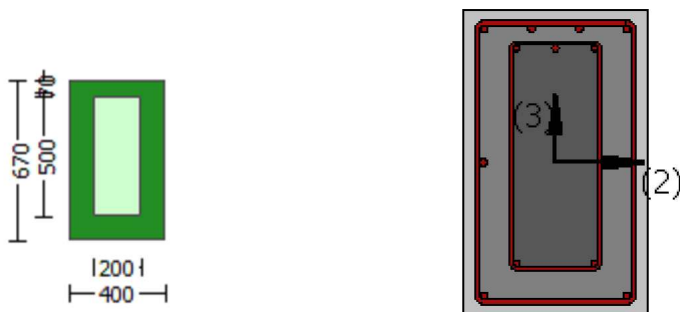
- Condition iv occurred  
Beam controlled by inadequate embedment into beam-column joint:  
( $l_b/d < 1$  and With Lapping in the Vicinity of the End Regions)
- Condition i occurred  
Beam controlled by flexure:  $V_p/V_o \leq 1$   
shear control ratio  $V_p/V_o = 0.49656722$
- Transverse Reinforcement: C
- Stirrup Spacing  $\leq d/3$
- Low ductility demand,  $\gamma / \gamma < 2$  (table 10-6, ASCE 41-17)  
 $= 1.7836020E-005$
- Stirrup Spacing  $\leq d/2$   
 $d = d_{\text{external}} = 627.00$   
 $s = s_{\text{external}} = 150.00$
- Strength provided by hoops  $V_s < 3/4 * \text{design Shear}$   
 $V_s = 371407.964$ , already given in calculation of shear control ratio  
design Shear = 18455.175
- ( $\rho_s - \rho_s' / \rho_{bal}$ ) = -0.26284228  
 $= A_{sl}/(b_w*d) = 0.00283094$   
Tension Reinf Area:  $A_{sl} = 709.9999$   
 $\rho_s' = A_{slc}/(b_w*d) = 0.00665146$

Compression Reinf Area:  $A_{scl} = 1668.186$   
 From (B-1), ACI 318-11:  $\rho_{bal} = 0.0145354$   
 $f_c = (f_{c\_jacket} \cdot \text{Area}_{jacket} + f_{c\_core} \cdot \text{Area}_{core}) / \text{section\_area} = 28.14925$   
 $f_y = f_{y\_jacket\_bars} = 555.56$   
 From 10.2.7.3, ACI 318-11:  $\beta_1 = 0.65$   
 From fig R10.3.3, ACI 318-11 (Ence 454, too):  $\rho_b / (\rho_b + f_y) = c_b / d_t = 0.003 / (0.003 + \rho_b) = 0.51922877$   
 $\rho_b = 0.0027778$   
 $V / (b_w \cdot d \cdot f_c^{0.5}) = 0.16702459$ , NOTE: units in lb & in  
 $b_w = 400.00$

-----  
 End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1  
 At local axis: 2  
 Integration Section: (b)

## Calculation No. 15

beam B1, Floor 1  
 Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)  
 Analysis: Uniform +X  
 Check: Shear capacity  $V_{Rd}$   
 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,  $\phi = 0.90$   
 Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.  
 Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17  
 Consequently:  
 Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 25.00$   
 New material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 500.00$   
 Concrete Elasticity,  $E_c = 26999.444$   
 Steel Elasticity,  $E_s = 200000.00$   
 Existing Column  
 Existing material of Primary Member: Concrete Strength,  $f_c = f_{c\_lower\_bound} = 16.00$   
 Existing material of Primary Member: Steel Strength,  $f_s = f_{s\_lower\_bound} = 400.00$   
 Concrete Elasticity,  $E_c = 21019.039$   
 Steel Elasticity,  $E_s = 200000.00$   
 External Height,  $H = 670.00$   
 External Width,  $W = 400.00$   
 Internal Height,  $H = 500.00$   
 Internal Width,  $W = 200.00$   
 Cover Thickness,  $c = 25.00$   
 Element Length,  $L = 3000.00$   
 Primary Member  
 Ribbed Bars  
 Ductile Steel  
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)  
 Longitudinal Bars With Ends Lapped Starting at the End Sections  
 Lap Length  $l_o = l_b = 300.00$   
 No FRP Wrapping

#### Stepwise Properties

EDGE -A-  
 Bending Moment,  $M_a = 8.9415E+006$   
 Shear Force,  $V_a = 1226.091$   
 EDGE -B-  
 Bending Moment,  $M_b = 1.6903E+007$   
 Shear Force,  $V_b = 18455.175$   
 BOTH EDGES  
 Axial Force,  $F = -9649.98$   
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
   -Tension:  $A_{st} = 709.9999$   
   -Compression:  $A_{sc} = 1668.186$   
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $A_{st,ten} = 709.9999$   
   -Compression:  $A_{sc,com} = 1266.062$   
   -Middle:  $A_{sc,mid} = 402.1239$   
 Mean Diameter of Tension Reinforcement,  $D_{bL,ten} = 15.00$

Existing component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $V_R = V_n = 426695.053$   
 $V_n ((22.5.1.1), ACI 318-14) = 474105.614$

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:  $V_c = 166648.413$   
   = 1 (normal-weight concrete)  
 Mean concrete strength:  $f'_c = (f'_{c\_jacket} * Area\_jacket + f'_{c\_core} * Area\_core) / Area\_section = 21.64179$ , but  $f_c^{0.5} < =$   
 8.3 MPa (22.5.3.1, ACI 318-14)  
 $p_w = A_s / (b_w * d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u * d / M_u < 1 = 0.58522559$   
 $M_u = 1.6903E+007$   
 $V_u = 18455.175$   
 From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 307457.201$   
 $V_{s1} = 280648.944$  is calculated for jacket, with:  
 $d = 536.00$   
 $A_v = 157079.633$

$$f_y = 500.00$$

$$s = 150.00$$

Vs1 has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

Vs2 = 26808.257 is calculated for core, with:

$$d = 400.00$$

$$A_v = 100530.965$$

$$f_y = 400.00$$

$$s = 300.00$$

Vs2 has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$$V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 662579.716$$

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

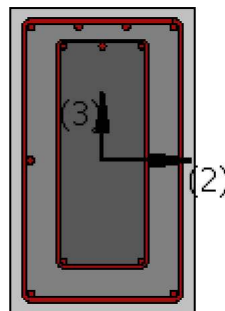
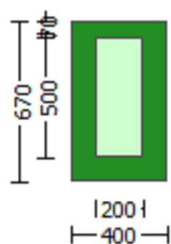
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (  $\mu$  )

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,  $\phi = 0.90$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$

New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$   
 Concrete Elasticity,  $E_c = 26999.444$   
 Steel Elasticity,  $E_s = 200000.00$   
 Existing Column  
 Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 20.00$   
 Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 444.44$   
 Concrete Elasticity,  $E_c = 21019.039$   
 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  
 Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 555.55$   
 #####  
 External Height,  $H = 670.00$   
 External Width,  $W = 400.00$   
 Internal Height,  $H = 500.00$   
 Internal Width,  $W = 200.00$   
 Cover Thickness,  $c = 25.00$   
 Mean Confinement Factor overall section = 1.00  
 Element Length,  $L = 3000.00$   
 Primary Member  
 Ribbed Bars  
 Ductile Steel  
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)  
 Longitudinal Bars With Ends Lapped Starting at the End Sections  
 Lap Length  $l_o = 300.00$   
 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,  $F = -2285.866$   
 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 ,  $V_e/V_r = 0.49656722$   
 Member Controlled by Flexure ( $V_e/V_r < 1$ )  
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 266008.163$   
 with  
 $M_{pr1} = \text{Max}(\mu_{u1+} , \mu_{u1-}) = 3.8425E+008$   
 $\mu_{u1+} = 2.2952E+008$ , 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  
 $\mu_{u1-} = 3.8425E+008$ , 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  
 $M_{pr2} = \text{Max}(\mu_{u2+} , \mu_{u2-}) = 3.8425E+008$   
 $\mu_{u2+} = 2.2952E+008$ , 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  
 $\mu_{u2-} = 3.8425E+008$ , 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

$$\pm v_{u*ln} = (|V1| + |V2|)/2$$

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 Mu1+  
-----

-----  
Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:

$$\phi_u = 1.2638035E-005$$

$$\mu_u = 2.2952E+008$$

-----  
with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027619$$

$$N = 2285.866$$

$$f_c = 33.00$$

$$\phi_{co} \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear\_factor} * \text{Max}(\phi_{cu}, \phi_{co}) = 0.00512221$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00512221$$

$$\phi_{we} \text{ (5.4c)} = 0.00164473$$

$$\phi_{ase} \text{ ((5.4d), TBDY)} = (\phi_{ase1} * A_{ext} + \phi_{ase2} * A_{int}) / A_{sec} = 0.14776895$$

$$\phi_{ase1} = 0.14776895$$

$$b_{o\_1} = 340.00$$

$$h_{o\_1} = 610.00$$

$$b_{i2\_1} = 975400.00$$

$$\phi_{ase2} = \text{Max}(\phi_{ase1}, \phi_{ase2}) = 0.14776895$$

$$b_{o\_2} = 192.00$$

$$h_{o\_2} = 492.00$$

$$b_{i2\_2} = 557856.00$$

$$\phi_{psh,min} * F_{ywe} = \text{Min}(\phi_{psh,x} * F_{ywe}, \phi_{psh,y} * F_{ywe}) = 1.22434$$

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)

$$\phi_{psh,x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{ps2} * F_{ywe2} = 2.16539$$

$$\phi_{ps1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{ps2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{psh,y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{ps2} * F_{ywe2} = 1.22434$$

$$\phi_{ps1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$$

$$\text{No stirrups, } n_{s\_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{ps2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * n_{s\_2} = 100.531$$

$$\text{No stirrups, } n_{s\_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_{cc} = 0.002$$

$$\phi_c = \text{confinement factor} = 1.00$$



```

y1 = 0.00154581
sh1 = 0.00494661
ft1 = 470.5847
fy1 = 392.1539
su1 = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.34790516
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 392.1539
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00154581
sh2 = 0.00494661
ft2 = 477.682
fy2 = 398.0683
su2 = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.34790516
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 = 398.0683
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00154581
shv = 0.00494661
ftv = 515.2755
fyv = 429.3962
suv = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.34790516
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 = 429.3962
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.03364135
2 = Asl,com/(b*d)*(fs2/fc) = 0.06089352
v = Asl,mid/(b*d)*(fsv/fc) = 0.02086299
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) = 0.0415669
2 = Asl,com/(b*d)*(fs2/fc) = 0.0752394
v = Asl,mid/(b*d)*(fsv/fc) = 0.0257781
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
---->
v < vs,y2 - LHS eq.(4.5) is satisfied
---->

```

su (4.9) = 0.1217168  
Mu = MRc (4.14) = 2.2952E+008  
u = su (4.1) = 1.2638035E-005

Calculation of ratio lb/l<sub>d</sub>

Lap Length: lb/l<sub>d</sub> = 0.34790516

lb = 300.00

l<sub>d</sub> = 862.304

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

= 1

db = 15.23077

Mean strength value of all re-bars: fy = 645.3439

t = 1.16154

s = 0.80

e = 1.00

cb = 25.00

K<sub>tr</sub> = 2.64216

n = 13.00

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 1.3095001E-005

Mu = 3.8425E+008

with full section properties:

b = 400.00

d = 627.00

d' = 43.00

v = 0.00027619

N = 2285.866

f<sub>c</sub> = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu: cu\* = shear\_factor \* Max( cu, cc) = 0.00512221

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.00512221

we (5.4c) = 0.00164473

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) = 1.22434

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 = 2.16539

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 = 1.22434

$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$   
 $Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$   
 $No \text{ stirups, } ns\_1 = 2.00$   
 $h1 = 400.00$   
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$   
 $Ash2 = Astir\_2 \cdot ns\_2 = 100.531$   
 $No \text{ stirups, } ns\_2 = 2.00$   
 $h2 = 200.00$

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.45

fywe2 = 555.55

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00154581

sh1 = 0.00494661

ft1 = 477.682

fy1 = 398.0683

su1 = 0.00695956

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

lo/lou,min = lb/ld = 0.34790516

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 = 398.0683

with Es1 = (Es,jacket\*Asl,ten,jacket + Es,core\*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00154581

sh2 = 0.00494661

ft2 = 470.5847

fy2 = 392.1539

su2 = 0.00695956

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

lo/lou,min = lb/lb,min = 0.34790516

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 = 392.1539

with Es2 = (Es,jacket\*Asl,com,jacket + Es,core\*Asl,com,core)/Asl,com = 200000.00

yv = 0.00154581

shv = 0.00494661

ftv = 515.2755

fyv = 429.3962

suv = 0.00695956

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

lo/lou,min = lb/ld = 0.34790516

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 = 429.3962

with Esv = (Es,jacket\*Asl,mid,jacket + Es,mid\*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.06089352

$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.03364135$   
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.02086299$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.0752394$   
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.0415669$   
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.0257781$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)

--->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.1523656$   
 $\mu_u = M_{Rc} (4.14) = 3.8425E+008$   
 $u = su (4.1) = 1.3095001E-005$

Calculation of ratio  $l_b/l_d$

Lap Length:  $l_b/l_d = 0.34790516$   
 $l_b = 300.00$   
 $l_d = 862.304$   
 Calculation of  $l_b, \min$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.  
 $= 1$   
 $db = 15.23077$   
 Mean strength value of all re-bars:  $f_y = 645.3439$   
 $t = 1.16154$   
 $s = 0.80$   
 $e = 1.00$   
 $cb = 25.00$   
 $K_{tr} = 2.64216$   
 $n = 13.00$

Calculation of  $\mu_{u2+}$

Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:  
 $u = 1.2638035E-005$   
 $\mu_u = 2.2952E+008$

with full section properties:

$b = 400.00$   
 $d = 627.00$   
 $d' = 43.00$   
 $v = 0.00027619$   
 $N = 2285.866$   
 $f_c = 33.00$   
 $co (5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.00512221$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00512221$   
 $we (5.4c) = 0.00164473$   
 $ase ((5.4d), TBDY) = (ase1*A_{ext} + ase2*A_{int})/A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo\_1 = 340.00$   
 $ho\_1 = 610.00$   
 $bi2\_1 = 975400.00$   
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$

$ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$   
 $psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.22434$   
 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)

$psh\_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.16539$   
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00261799$   
 $Ash1 = Astir\_1*ns\_1 = 157.0796$   
 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,  $ns\_2 = 2.00$   
 $h2 = 500.00$

$psh\_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.22434$   
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00156298$   
 $Ash1 = Astir\_1*ns\_1 = 157.0796$   
 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,  $ns\_2 = 2.00$   
 $h2 = 200.00$

$Asec = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fywe1 = 694.45$   
 $fywe2 = 555.55$   
 $fce = 33.00$

From ((5.A5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$

$y1 = 0.00154581$   
 $sh1 = 0.00494661$   
 $ft1 = 470.5847$   
 $fy1 = 392.1539$   
 $su1 = 0.00695956$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$

$lo/lou,min = lb/ld = 0.34790516$

$su1 = 0.4*esu1\_nominal \text{ ((5.5), TBDY)} = 0.032$

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  $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 392.1539$

with  $Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$

$y2 = 0.00154581$   
 $sh2 = 0.00494661$   
 $ft2 = 477.682$   
 $fy2 = 398.0683$   
 $su2 = 0.00695956$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$

$lo/lou,min = lb/lb,min = 0.34790516$

$su2 = 0.4*esu2\_nominal \text{ ((5.5), TBDY)} = 0.032$

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  $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 398.0683$

with  $Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$

$yv = 0.00154581$

$shv = 0.00494661$   
 $ftv = 515.2755$   
 $fyv = 429.3962$   
 $suv = 0.00695956$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $Shear\_factor = 1.00$   
 $lo/lou,min = lb/ld = 0.34790516$   
 $suv = 0.4 * esuv\_nominal ((5.5), TBDY) = 0.032$   
 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  $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 429.3962$   
 with  $Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$   
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.03364135$   
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.06089352$   
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.02086299$   
 and confined core properties:  
 $b = 340.00$   
 $d = 597.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.0415669$   
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.0752394$   
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.0257781$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < vs,y2$  - LHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.1217168$   
 $Mu = MRc (4.14) = 2.2952E+008$   
 $u = su (4.1) = 1.2638035E-005$

#### Calculation of ratio $lb/ld$

Lap Length:  $lb/ld = 0.34790516$   
 $lb = 300.00$   
 $ld = 862.304$   
 Calculation of  $lb,min$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.  
 $= 1$   
 $db = 15.23077$   
 Mean strength value of all re-bars:  $fy = 645.3439$   
 $t = 1.16154$   
 $s = 0.80$   
 $e = 1.00$   
 $cb = 25.00$   
 $Ktr = 2.64216$   
 $n = 13.00$

#### Calculation of $Mu2$ -

Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:  
 $u = 1.3095001E-005$   
 $Mu = 3.8425E+008$

with full section properties:  
 $b = 400.00$



```

y2 = 0.00154581
sh2 = 0.00494661
ft2 = 470.5847
fy2 = 392.1539
su2 = 0.00695956
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.34790516
    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 = 392.1539
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00154581
shv = 0.00494661
ftv = 515.2755
fyv = 429.3962
suv = 0.00695956
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 0.34790516
    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 = 429.3962
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06089352
2 = Asl,com/(b*d)*(fs2/fc) = 0.03364135
v = Asl,mid/(b*d)*(fsv/fc) = 0.02086299
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) = 0.0752394
2 = Asl,com/(b*d)*(fs2/fc) = 0.0415669
v = Asl,mid/(b*d)*(fsv/fc) = 0.0257781
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1523656
Mu = MRc (4.14) = 3.8425E+008
u = su (4.1) = 1.3095001E-005

```

Calculation of ratio lb/lb

```

Lap Length: lb/lb = 0.34790516
lb = 300.00
lb = 862.304
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 645.3439
t = 1.16154
s = 0.80

```



e = 1.00  
cb = 25.00  
Ktr = 2.64216  
n = 13.00

Calculation of Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 535694.165$

Calculation of Shear Strength at edge 1,  $V_{r1} = 535694.165$   
 $V_{r1} = V_n$  ((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:  $V_c = 194072.856$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot \text{Area}_{jacket} + f'_{c\_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 28.14925$ , but  $f_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / \mu_u < 1 = 1.00$   
 $\mu_u = 1.1086 \text{E}+006$   
 $V_u = 9840.632$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 341621.309$   
 $V_{s1} = 311834.654$  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)  
 $V_{s2} = 29786.655$  is calculated for jacket, with:  
 $d_2 = 400.00$   
 $A_v = 100530.965$   
 $f_y = 444.44$   
 $s = 300.00$   
 $V_{s2}$  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:  $V_s + V_f \leq 755657.47$

Calculation of Shear Strength at edge 2,  $V_{r2} = 535694.165$   
 $V_{r2} = V_n$  ((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:  $V_c = 194072.856$   
= 1 (normal-weight concrete)  
Mean concrete strength:  $f'_c = (f'_{c\_jacket} \cdot \text{Area}_{jacket} + f'_{c\_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 28.14925$ , but  $f_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 400.00$   
 $d = 536.00$   
 $V_u \cdot d / \mu_u < 1 = 1.00$   
 $\mu_u = 1.1086 \text{E}+006$   
 $V_u = 9840.634$   
From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 341621.309$   
 $V_{s1} = 311834.654$  is calculated for jacket, with:  
 $d = 536.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$

Vs1 has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
Vs2 = 29786.655 is calculated for jacket, with:  
 $d = 400.00$   
 $A_v = 100530.965$   
 $f_y = 444.44$   
 $s = 300.00$   
Vs2 has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)  
 $2(1-s/d) = 0.50$   
 $V_f((11-3)-(11.4), \text{ACI } 440) = 0.00$   
From (11-11), ACI 440:  $V_s + V_f \leq 755657.47$

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,  $\phi = 0.90$   
Mean strength values are used for both shear and moment calculations.  
Consequently:  
Jacket  
New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 33.00$   
New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 555.56$   
Concrete Elasticity,  $E_c = 26999.444$   
Steel Elasticity,  $E_s = 200000.00$   
Existing Column  
Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 20.00$   
Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 444.44$   
Concrete Elasticity,  $E_c = 21019.039$   
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  
Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 555.55$   
#####  
External Height,  $H = 670.00$   
External Width,  $W = 400.00$   
Internal Height,  $H = 500.00$   
Internal Width,  $W = 200.00$   
Cover Thickness,  $c = 25.00$   
Mean Confinement Factor overall section = 1.00  
Element Length,  $L = 3000.00$   
Primary Member  
Ribbed Bars  
Ductile Steel  
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)  
Longitudinal Bars With Ends Lapped Starting at the End Sections  
Lap Length  $l_o = 300.00$   
No FRP Wrapping

#### Stepwise Properties

At local axis: 2  
EDGE -A-  
Shear Force,  $V_a = 4.8511603E-015$   
EDGE -B-

Shear Force,  $V_b = -4.8511603E-015$

BOTH EDGES

Axial Force,  $F = -2285.866$

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,  $V_e/V_r = 0.30156355$

Member Controlled by Flexure ( $V_e/V_r < 1$ )

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 111027.496$  with

$M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 1.6654E+008$

$\mu_{u1+} = 1.6654E+008$ , 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

$\mu_{u1-} = 1.6654E+008$ , 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

$M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 1.6654E+008$

$\mu_{u2+} = 1.6654E+008$ , 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

$\mu_{u2-} = 1.6654E+008$ , 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

$V_1 = 4.8511603E-015$ , is the shear force acting at edge 1 for the static loading combination

$V_2 = -4.8511603E-015$ , 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:

$\phi_u = 2.2916591E-005$

$M_u = 1.6654E+008$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.0002896$

$N = 2285.866$

$f_c = 33.00$

$\phi_c$  (5A.5, TBDY) = 0.002

Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00512221$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $\phi_u = 0.00512221$

$w_e$  (5.4c) = 0.00164473

$a_{se}$  ((5.4d), TBDY) =  $(a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int})/A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o\_1} = 340.00$

$h_{o\_1} = 610.00$

$b_{i2\_1} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o\_2} = 192.00$

$h_{o\_2} = 492.00$

$b_{i2\_2} = 557856.00$

$\phi_{sh,min} \cdot F_{ywe} = \text{Min}(\phi_{sh,x} \cdot F_{ywe}, \phi_{sh,y} \cdot F_{ywe}) = 1.22434$

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)

$psh\_x \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 2.16539$   
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00261799$   
 $Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$   
 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,  $ns\_2 = 2.00$   
 $h2 = 500.00$

$psh\_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.22434$   
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$   
 $Ash1 = Astir\_1 \cdot ns\_1 = 157.0796$   
 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,  $ns\_2 = 2.00$   
 $h2 = 200.00$

$Asec = 268000.00$

$s1 = 150.00$

$s2 = 300.00$

$fywe1 = 694.45$

$fywe2 = 555.55$

$fce = 33.00$

From ((5.A.5), TBDY), TBDY:  $cc = 0.002$

$c = \text{confinement factor} = 1.00$

$y1 = 0.00154581$

$sh1 = 0.00494661$

$ft1 = 480.4475$

$fy1 = 400.3729$

$su1 = 0.00695956$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$lo/lou, min = lb/ld = 0.34790516$

$su1 = 0.4 \cdot esu1\_nominal \text{ ((5.5), TBDY)} = 0.032$

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  $fs1 = (fs\_jacket \cdot Asl, ten, jacket + fs\_core \cdot Asl, ten, core) / Asl, ten = 400.3729$

with  $Es1 = (Es\_jacket \cdot Asl, ten, jacket + Es\_core \cdot Asl, ten, core) / Asl, ten = 200000.00$

$y2 = 0.00154581$

$sh2 = 0.00494661$

$ft2 = 480.4475$

$fy2 = 400.3729$

$su2 = 0.00695956$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$lo/lou, min = lb/lb, min = 0.34790516$

$su2 = 0.4 \cdot esu2\_nominal \text{ ((5.5), TBDY)} = 0.032$

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  $fs2 = (fs\_jacket \cdot Asl, com, jacket + fs\_core \cdot Asl, com, core) / Asl, com = 400.3729$

with  $Es2 = (Es\_jacket \cdot Asl, com, jacket + Es\_core \cdot Asl, com, core) / Asl, com = 200000.00$

$yv = 0.00154581$

$shv = 0.00494661$

$ftv = 486.7441$

$fyv = 405.62$

$suv = 0.00695956$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor

and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $l_o/l_{ou,min} = l_b/l_d = 0.34790516$   
 $suv = 0.4 * esuv\_nominal ((5.5), TBDY) = 0.032$   
 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  $fsv = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 405.62$   
 with  $Esv = (Es_{jacket} * Asl_{mid,jacket} + Es_{mid} * Asl_{mid,core}) / Asl_{mid} = 200000.00$   
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.04621209$   
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.04621209$   
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.02857496$   
 and confined core properties:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.05541419$   
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.05541419$   
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.03426502$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.14932546$   
 $Mu = MRc (4.14) = 1.6654E+008$   
 $u = su (4.1) = 2.2916591E-005$

---

Calculation of ratio  $l_b/l_d$

---

Lap Length:  $l_b/l_d = 0.34790516$   
 $l_b = 300.00$   
 $l_d = 862.304$   
 Calculation of  $l_b,min$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.  
 $= 1$   
 $db = 15.23077$   
 Mean strength value of all re-bars:  $fy = 645.3439$   
 $t = 1.16154$   
 $s = 0.80$   
 $e = 1.00$   
 $cb = 25.00$   
 $Ktr = 2.64216$   
 $n = 13.00$

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Calculation of  $Mu_1$ -

---

Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:  
 $u = 2.2916591E-005$   
 $Mu = 1.6654E+008$

---

with full section properties:

$b = 670.00$   
 $d = 357.00$   
 $d' = 43.00$   
 $v = 0.0002896$   
 $N = 2285.866$   
 $fc = 33.00$

$co$  (5A.5, TBDY) = 0.002  
 Final value of  $cu$ :  $cu^* = shear\_factor * Max(cu, cc) = 0.00512221$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.00512221$   
 $we$  (5.4c) = 0.00164473  
 $ase$  ((5.4d), TBDY) =  $(ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$   
 $ase1 = 0.14776895$   
 $bo\_1 = 340.00$   
 $ho\_1 = 610.00$   
 $bi2\_1 = 975400.00$   
 $ase2 = Max(ase1, ase2) = 0.14776895$   
 $bo\_2 = 192.00$   
 $ho\_2 = 492.00$   
 $bi2\_2 = 557856.00$   
 $psh, min * F_{ywe} = Min(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.22434$   
 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)

$psh, x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.16539$   
 $ps1$  (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,  $ns\_2 = 2.00$   
 $h2 = 500.00$

$psh, y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.22434$   
 $ps1$  (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,  $ns\_2 = 2.00$   
 $h2 = 200.00$

$A_{sec} = 268000.00$   
 $s1 = 150.00$   
 $s2 = 300.00$   
 $fywe1 = 694.45$   
 $fywe2 = 555.55$   
 $fce = 33.00$

From ((5.A5), TBDY), TBDY:  $cc = 0.002$   
 $c =$  confinement factor = 1.00

$y1 = 0.00154581$   
 $sh1 = 0.00494661$   
 $ft1 = 480.4475$   
 $fy1 = 400.3729$   
 $su1 = 0.00695956$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00

$lo/lo_{u,min} = lb/ld = 0.34790516$

$su1 = 0.4 * esu1\_nominal$  ((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  $fs1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 400.3729$

with  $Es1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$

$y2 = 0.00154581$   
 $sh2 = 0.00494661$   
 $ft2 = 480.4475$   
 $fy2 = 400.3729$   
 $su2 = 0.00695956$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00  
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.34790516$   
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$   
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  $fs_2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 400.3729$   
with  $Es_2 = (Es_{jacket} \cdot Asl_{com,jacket} + Es_{core} \cdot Asl_{com,core}) / Asl_{com} = 200000.00$   
 $y_v = 0.00154581$   
 $sh_v = 0.00494661$   
 $ft_v = 486.7441$   
 $fy_v = 405.62$   
 $suv = 0.00695956$   
using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00  
 $l_o/l_{ou,min} = l_b/l_d = 0.34790516$   
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$   
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  $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 405.62$   
with  $Es_v = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$   
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.04621209$   
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.04621209$   
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.02857496$   
and confined core properties:  
 $b = 610.00$   
 $d = 327.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.05541419$   
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.05541419$   
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.03426502$   
Case/Assumption: Unconfined full section - Steel rupture  
' satisfies Eq. (4.3)  
--->  
 $v < v_{s,y_2}$  - LHS eq.(4.5) is satisfied  
--->  
 $su (4.9) = 0.14932546$   
 $Mu = MRc (4.14) = 1.6654E+008$   
 $u = su (4.1) = 2.2916591E-005$

#### Calculation of ratio $l_b/l_d$

Lap Length:  $l_b/l_d = 0.34790516$   
 $l_b = 300.00$   
 $l_d = 862.304$   
Calculation of  $l_{b,min}$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.  
 $= 1$   
 $db = 15.23077$   
Mean strength value of all re-bars:  $fy = 645.3439$   
 $t = 1.16154$   
 $s = 0.80$   
 $e = 1.00$   
 $cb = 25.00$   
 $K_{tr} = 2.64216$   
 $n = 13.00$

## Calculation of Mu2+

Calculation of ultimate curvature  $\mu$  according to 4.1, Biskinis/Fardis 2013:

$$\mu = 2.2916591\text{E-}005$$

$$Mu = 1.6654\text{E+}008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0002896$$

$$N = 2285.866$$

$$f_c = 33.00$$

$$cc \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear\_factor} * \text{Max}(\mu, cc) = 0.00512221$$

The Shear\_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu = 0.00512221$$

$$w_e \text{ (5.4c)} = 0.00164473$$

$$ase \text{ ((5.4d), TBDY)} = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo\_1 = 340.00$$

$$ho\_1 = 610.00$$

$$bi2\_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo\_2 = 192.00$$

$$ho\_2 = 492.00$$

$$bi2\_2 = 557856.00$$

$$psh, \min * F_{ywe} = \text{Min}(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.22434$$

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)

$$psh, x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.16539$$

$$ps1 \text{ (external)} = (A_{sh1} * h1 / s1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir\_1} * ns\_1 = 157.0796$$

$$\text{No stirrups, } ns\_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (A_{sh2} * h2 / s2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir\_2} * ns\_2 = 100.531$$

$$\text{No stirrups, } ns\_2 = 2.00$$

$$h2 = 500.00$$

$$psh, y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.22434$$

$$ps1 \text{ (external)} = (A_{sh1} * h1 / s1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir\_1} * ns\_1 = 157.0796$$

$$\text{No stirrups, } ns\_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (A_{sh2} * h2 / s2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir\_2} * ns\_2 = 100.531$$

$$\text{No stirrups, } ns\_2 = 2.00$$

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.00154581$$

$$sh1 = 0.00494661$$

$$ft1 = 480.4475$$

$$fy1 = 400.3729$$



```

su1 = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.34790516
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 = 400.3729
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00154581
sh2 = 0.00494661
ft2 = 480.4475
fy2 = 400.3729
su2 = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.34790516
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 = 400.3729
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00154581
shv = 0.00494661
ftv = 486.7441
fyv = 405.62
suv = 0.00695956
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.34790516
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 = 405.62
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04621209
2 = Asl,com/(b*d)*(fs2/fc) = 0.04621209
v = Asl,mid/(b*d)*(fsv/fc) = 0.02857496
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) = 0.05541419
2 = Asl,com/(b*d)*(fs2/fc) = 0.05541419
v = Asl,mid/(b*d)*(fsv/fc) = 0.03426502
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.14932546
Mu = MRc (4.14) = 1.6654E+008
u = su (4.1) = 2.2916591E-005

```

#### Calculation of ratio $l_b/l_d$

Lap Length:  $l_b/l_d = 0.34790516$

$l_b = 300.00$

$l_d = 862.304$

Calculation of  $l_b$ ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$= 1$

$db = 15.23077$

Mean strength value of all re-bars:  $f_y = 645.3439$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

#### Calculation of $\mu_u$

Calculation of ultimate curvature  $\mu_u$  according to 4.1, Biskinis/Fardis 2013:

$\mu_u = 2.2916591E-005$

$\mu_u = 1.6654E+008$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.0002896$

$N = 2285.866$

$f_c = 33.00$

$\phi_c$  (5A.5, TBDY) = 0.002

Final value of  $\phi_c$ :  $\phi_c^* = \text{shear\_factor} * \text{Max}(\phi_c, \phi_c) = 0.00512221$

The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $\phi_c = 0.00512221$

$\phi_w$  (5.4c) = 0.00164473

$\phi_{se}$  ((5.4d), TBDY) =  $(\phi_{se1} * A_{ext} + \phi_{se2} * A_{int}) / A_{sec} = 0.14776895$

$\phi_{se1} = 0.14776895$

$b_{o\_1} = 340.00$

$h_{o\_1} = 610.00$

$b_{i2\_1} = 975400.00$

$\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$

$b_{o\_2} = 192.00$

$h_{o\_2} = 492.00$

$b_{i2\_2} = 557856.00$

$\phi_{sh,min} * F_{ywe} = \text{Min}(\phi_{sh,x} * F_{ywe}, \phi_{sh,y} * F_{ywe}) = 1.22434$

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)

$\phi_{sh,x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.16539$

$\phi_{s1}$  (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,  $n_{s\_2} = 2.00$

$h_2 = 500.00$

$\phi_{sh,y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.22434$

$\phi_{s1}$  (external) =  $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$

$A_{sh1} = A_{stir\_1} * n_{s\_1} = 157.0796$

No stirrups,  $n_{s\_1} = 2.00$

$h_1 = 400.00$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$$

$$Ash2 = Astir\_2 \cdot ns\_2 = 100.531$$

$$No \text{ stirups, } ns\_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.45$$

$$fywe2 = 555.55$$

$$fce = 33.00$$

$$\text{From } ((5.A5), \text{ TBDY}), \text{ TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.00154581$$

$$sh1 = 0.00494661$$

$$ft1 = 480.4475$$

$$fy1 = 400.3729$$

$$su1 = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou, \min = lb/ld = 0.34790516$$

$$su1 = 0.4 \cdot esu1\_nominal ((5.5), \text{ TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu1\_nominal = 0.08,$$

For calculation of esu1\_nominal and y1, sh1, ft1, fy1, it is considered  
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs1 = (fs\_jacket \cdot Asl, \text{ten, jacket} + fs\_core \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 400.3729$$

$$\text{with } Es1 = (Es\_jacket \cdot Asl, \text{ten, jacket} + Es\_core \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.00154581$$

$$sh2 = 0.00494661$$

$$ft2 = 480.4475$$

$$fy2 = 400.3729$$

$$su2 = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 0.34790516$$

$$su2 = 0.4 \cdot esu2\_nominal ((5.5), \text{ TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu2\_nominal = 0.08,$$

For calculation of esu2\_nominal and y2, sh2, ft2, fy2, it is considered  
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs2 = (fs\_jacket \cdot Asl, \text{com, jacket} + fs\_core \cdot Asl, \text{com, core}) / Asl, \text{com} = 400.3729$$

$$\text{with } Es2 = (Es\_jacket \cdot Asl, \text{com, jacket} + Es\_core \cdot Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.00154581$$

$$shv = 0.00494661$$

$$ftv = 486.7441$$

$$fyv = 405.62$$

$$suv = 0.00695956$$

using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
Shear\_factor = 1.00

$$lo/lou, \min = lb/ld = 0.34790516$$

$$suv = 0.4 \cdot esuv\_nominal ((5.5), \text{ TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esuv\_nominal = 0.08,$$

$$\text{considering characteristic value } fsyv = fsv/1.2, \text{ from table 5.1, TBDY}$$

For calculation of esuv\_nominal and yv, shv, ftv, fyv, it is considered  
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fsv = (fs\_jacket \cdot Asl, \text{mid, jacket} + fs\_mid \cdot Asl, \text{mid, core}) / Asl, \text{mid} = 405.62$$

$$\text{with } Esv = (Es\_jacket \cdot Asl, \text{mid, jacket} + Es\_mid \cdot Asl, \text{mid, core}) / Asl, \text{mid} = 200000.00$$

$$1 = Asl, \text{ten} / (b \cdot d) \cdot (fs1 / fce) = 0.04621209$$

$$2 = Asl, \text{com} / (b \cdot d) \cdot (fs2 / fce) = 0.04621209$$

$$v = Asl, \text{mid} / (b \cdot d) \cdot (fsv / fce) = 0.02857496$$

and confined core properties:

$$b = 610.00$$

$d = 327.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 33.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{s1,ten}/(b*d)*(f_{s1}/f_c) = 0.05541419$   
 $2 = A_{s2,com}/(b*d)*(f_{s2}/f_c) = 0.05541419$   
 $v = A_{s,mid}/(b*d)*(f_{sv}/f_c) = 0.03426502$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)

--->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.14932546$   
 $Mu = MRc (4.14) = 1.6654E+008$   
 $u = su (4.1) = 2.2916591E-005$

Calculation of ratio  $l_b/l_d$

Lap Length:  $l_b/l_d = 0.34790516$   
 $l_b = 300.00$   
 $l_d = 862.304$   
 Calculation of  $l_b, \min$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.  
 $= 1$   
 $db = 15.23077$   
 Mean strength value of all re-bars:  $f_y = 645.3439$   
 $t = 1.16154$   
 $s = 0.80$   
 $e = 1.00$   
 $cb = 25.00$   
 $K_{tr} = 2.64216$   
 $n = 13.00$

Calculation of Shear Strength  $V_r = \min(V_{r1}, V_{r2}) = 368172.80$

Calculation of Shear Strength at edge 1,  $V_{r1} = 368172.80$   
 $V_{r1} = V_n ((22.5.1.1), ACI 318-14)$

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:  $V_c = 182002.857$   
 $= 1$  (normal-weight concrete)  
 Mean concrete strength:  $f'_c = (f'_{c,jacket} * \text{Area}_{jacket} + f'_{c,core} * \text{Area}_{core}) / \text{Area}_{section} = 28.14925$ , but  $f_c^{0.5} < =$   
 8.3 MPa (22.5.3.1, ACI 318-14)  
 $pw = A_s / (b_w * d) = 0.00331157$   
 $A_s$  (tension reinf.) = 709.9999  
 $b_w = 670.00$   
 $d = 320.00$   
 $V_u * d / Mu < 1 = 0.00$   
 $Mu = 6.4841010E-012$   
 $V_u = 4.8511603E-015$   
 From (11.5.4.8), ACI 318-14:  $V_{s1} + V_{s2} = 186169.943$   
 $V_{s1} = 186169.943$  is calculated for jacket, with:  
 $d = 320.00$   
 $A_v = 157079.633$   
 $f_y = 555.56$   
 $s = 150.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17, 10.3.4)  
 $V_{s2} = 0.00$  is calculated for jacket, with:  
 $d_2 = 160.00$   
 $A_v = 100530.965$   
 $f_y = 444.44$

$$s = 300.00$$

Vs2 is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

$$V_f((11-3)-(11.4), \text{ACI 440}) = 0.00$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 755657.47$$

Calculation of Shear Strength at edge 2,  $V_{r2} = 368172.80$

$$V_{r2} = V_n((22.5.1.1), \text{ACI 318-14})$$

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).

$$\text{From Table (22.5.5.1), ACI 318-14: } V_c = 182002.857$$

$$= 1 \text{ (normal-weight concrete)}$$

$$\text{Mean concrete strength: } f'_c = (f'_{c\_jacket} \cdot \text{Area}_{jacket} + f'_{c\_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 28.14925, \text{ but } f'_c^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$p_w = A_s / (b_w \cdot d) = 0.00331157$$

$$A_s \text{ (tension reinf.)} = 709.9999$$

$$b_w = 670.00$$

$$d = 320.00$$

$$V_u \cdot d / M_u < 1 = 0.00$$

$$M_u = 8.0658469 \text{E-012}$$

$$V_u = 4.8511603 \text{E-015}$$

$$\text{From (11.5.4.8), ACI 318-14: } V_{s1} + V_{s2} = 186169.943$$

$V_{s1} = 186169.943$  is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

$V_{s1}$  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:

$$d = 160.00$$

$$A_v = 100530.965$$

$$f_y = 444.44$$

$$s = 300.00$$

Vs2 is considered 0 ( $s > d$ , according to ASCE 41-17,10.3.4)

$$V_f((11-3)-(11.4), \text{ACI 440}) = 0.00$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 755657.47$$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)

Section Type: rcjars

Constant Properties

$$\text{Knowledge Factor, } \phi = 0.90$$

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

$$\text{New material of Primary Member: Concrete Strength, } f_c = f_{cm} = 33.00$$

$$\text{New material of Primary Member: Steel Strength, } f_s = f_{sm} = 555.56$$

$$\text{Concrete Elasticity, } E_c = 26999.444$$

$$\text{Steel Elasticity, } E_s = 200000.00$$

Existing Column

$$\text{Existing material of Primary Member: Concrete Strength, } f_c = f_{cm} = 20.00$$

$$\text{Existing material of Primary Member: Steel Strength, } f_s = f_{sm} = 444.44$$

$$\text{Concrete Elasticity, } E_c = 21019.039$$

$$\text{Steel Elasticity, } E_s = 200000.00$$

$$\text{External Height, } H = 670.00$$

$$\text{External Width, } W = 400.00$$

Internal Height, H = 500.00  
 Internal Width, W = 200.00  
 Cover Thickness, c = 25.00  
 Element Length, L = 3000.00  
 Primary Member  
 Ribbed Bars  
 Ductile Steel  
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)  
 Longitudinal Bars With Ends Lapped Starting at the End Sections  
 Lap Length  $l_b$  = 300.00  
 No FRP Wrapping

#### Stepwise Properties

Bending Moment, M = 5.4215417E-011  
 Shear Force, V2 = -8.5432615E-015  
 Shear Force, V3 = 18455.175  
 Axial Force, F = -9649.98  
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
   -Tension:  $A_{st}$  = 709.9999  
   -Compression:  $A_{sc}$  = 1668.186  
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $A_{st,ten}$  = 911.0619  
   -Compression:  $A_{sc,com}$  = 911.0619  
   -Middle:  $A_{st,mid}$  = 556.0619  
 Longitudinal External Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $A_{st,ten,jacket}$  = 603.1858  
   -Compression:  $A_{sc,com,jacket}$  = 603.1858  
   -Middle:  $A_{st,mid,jacket}$  = 402.1239  
 Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $A_{st,ten,core}$  = 307.8761  
   -Compression:  $A_{sc,com,core}$  = 307.8761  
   -Middle:  $A_{st,mid,core}$  = 153.938  
 Mean Diameter of Tension Reinforcement,  $D_bL$  = 15.20

Existing component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u_R = \gamma + p = 0.02940626$

- Calculation of  $\gamma$  -

$\gamma = (M_y * L_s / 3) / E_{eff} = 0.00267362$  ((4.29), Biskinis Phd))  
 $M_y = 1.3478E+008$   
 $L_s = M/V$  (with  $L_s > 0.1 * L$  and  $L_s < 2 * L$ ) = 1500.00  
 From table 10.5, ASCE 41\_17:  $E_{eff} = 0.3 * E_c * I_g = 2.5206E+013$

#### Calculation of Yielding Moment $M_y$

Calculation of  $\gamma$  and  $M_y$  according to Annex 7 -

$\gamma = \text{Min}(\gamma_{ten}, \gamma_{com})$   
 $\gamma_{ten} = 6.7373176E-006$   
 with ((10.1), ASCE 41-17)  $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b / d)^{2/3}) = 372.8122$   
 $d = 357.00$   
 $\gamma = 0.22499433$   
 $A = 0.01005088$   
 $B = 0.00567834$   
 with  $p_t = 0.00380895$   
 $p_c = 0.00380895$   
 $p_v = 0.00232477$   
 $N = 9649.98$

$b = 670.00$   
 $" = 0.12044818$   
 $y_{comp} = 2.7583235E-005$   
 with  $f_c = 28.14925$   
 $E_c = 26999.444$   
 $y = 0.22341802$   
 $A = 0.00985097$   
 $B = 0.00557012$   
 with  $E_s = 200000.00$

Calculation of ratio  $l_b/d$

Lap Length:  $l_d/d, min = 0.43488144$   
 $l_b = 300.00$   
 $l_d = 689.8432$

Calculation of  $l$  according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$= 1$   
 $db = 15.23077$   
 Mean strength value of all re-bars:  $f_y = 516.2752$   
 $t = 1.16154$   
 $s = 0.80$   
 $e = 1.00$   
 $cb = 25.00$   
 $K_{tr} = 2.64216$   
 $n = 13.00$

- Calculation of  $p$  -

From table 10-7:  $p = 0.03$   
 with:

- Condition iv occurred

Beam controlled by inadequate embedment into beam-column joint:  
 $(l_b/d < 1$  and With Lapping in the Vicinity of the End Regions

- Condition i occurred

Beam controlled by flexure:  $V_p/V_o \leq 1$   
 shear control ratio  $V_p/V_o = 0.30156355$

- Transverse Reinforcement: NC

- Stirrup Spacing  $> d/3$

- Low ductility demand,  $\gamma < 2$  (table 10-6, ASCE 41-17)  
 $= 3.5037908E-022$

- Stirrup Spacing  $\leq d/2$

$d = d_{external} = 357.00$

$s = s_{external} = 150.00$

- Strength provided by hoops  $V_s < 3/4 \cdot \text{design Shear}$

$V_s = 209999.267$ , already given in calculation of shear control ratio

design Shear =  $8.5432615E-015$

-  $(-)' / bal = -0.27560034$

$= A_{st}/(b_w \cdot d) = 0.00296835$

Tension Reinf Area:  $A_{st} = 709.9999$

$' = A_{sc}/(b_w \cdot d) = 0.00697431$

Compression Reinf Area:  $A_{sc} = 1668.186$

From (B-1), ACI 318-11:  $bal = 0.0145354$

$f_c = (f_{c\_jacket} \cdot \text{Area}_{jacket} + f_{c\_core} \cdot \text{Area}_{core}) / \text{section\_area} = 28.14925$

$f_y = f_{y\_jacket\_bars} = 555.56$

From 10.2.7.3, ACI 318-11:  $\gamma = 0.65$

From fig R10.3.3, ACI 318-11 (Ence 454, too):  $87000 / (87000 + f_y) = cb/dt = 0.003 / (0.003 + \gamma) = 0.51922877$   
 $\gamma = 0.0027778$

$- V / (b_w \cdot d \cdot f_c^{0.5}) = 8.1071922E-020$ , NOTE: units in lb & in  
 $b_w = 670.00$

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)

