

# Detailed Member Calculations

Units: N&mm

Regulation: ASCE 41-17

## Calculation No. 1

- wall W1, Floor 1
- Limit State: Operational Level (data interpolation between analysis steps 1 and 2)
- Analysis: Uniform +X
- Check: Shear capacity  $V_{Rd}$
- Edge: Start
- Local Axis: (2)



- Start Of Calculation of Shear Capacity for element: wall W1 of floor 1
- At local axis: 2
- Integration Section: (a)
- Section Type: rcrws

Constant Properties

- Knowledge Factor,  $\gamma = 1.00$
- Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
- Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
- Consequently:
- 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,  $E_s = 200000.00$   
 Total Height,  $H_{tot} = 3000.00$   
 Edges Width,  $W_{edg} = 250.00$   
 Edges Height,  $H_{edg} = 600.00$   
 Web Width,  $W_{web} = 250.00$   
 Cover Thickness,  $c = 25.00$   
 Element Length,  $L = 3000.00$   
 Primary Member  
 Ribbed Bars  
 Ductile Steel  
 With Detailing for Earthquake Resistance (including stirrups closed at  $135^\circ$ )  
 Longitudinal Bars With Ends Lapped Starting at the End Sections  
 Adequate Lap Length ( $l_o/l_{ou,min} = l_b/l_d \geq 1$ )  
 No FRP Wrapping

#### Stepwise Properties

EDGE -A-  
 Bending Moment,  $M_a = -1.3025053E-010$   
 Shear Force,  $V_a = -6.3979846E-014$   
 EDGE -B-  
 Bending Moment,  $M_b = -6.2019971E-011$   
 Shear Force,  $V_b = 6.3979846E-014$   
 BOTH EDGES  
 Axial Force,  $F = -27598.912$   
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
   -Tension:  $A_{st} = 0.00$   
   -Compression:  $A_{sc} = 6346.017$   
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $A_{st,ten} = 2368.761$   
   -Compression:  $A_{st,com} = 2368.761$   
   -Middle:  $A_{st,mid} = 1608.495$   
 Mean Diameter of Tension Reinforcement,  $Db_{L,ten} = 17.20$

Existing component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $V_R = V_n = 403305.524$   
 From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d = 403305.524$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 151978.111$   
 $\mu_u / \mu - l_w / 2 = 1910.806 > 0$   
   = 1 (normal-weight concrete)  
 $f_c' = 16.00$ , but  $f_c'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $h = 3000.00$   
 $d = 200.00$   
 $l_w = 250.00$   
 $\mu_u = 1.3025053E-010$   
 $V_u = 6.3979846E-014$   
 $N_u = 27598.912$   
 From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 251327.412$   
 $V_{s1} = 125663.706$  is calculated for pseudo-Column 1, with:  
 $d = 200.00$   
 $A_v = 157079.633$   
 $s = 100.00$   
 $f_y = 400.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 125663.706$  is calculated for pseudo-Column 2, with:  
 $d = 200.00$   
 $A_v = 157079.633$   
 $s = 100.00$   
 $f_y = 400.00$   
 $V_{s2}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

Vs3 = 0.00 is calculated for web, with:

d = 200.00

Av = 0.00

s = 200.00

fy = 400.00

Vs3 has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

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

From (11-11), ACI 440: Vs + Vf <= 1.5943E+006

bw = 3000.00

End Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (a)

## Calculation No. 2

wall W1, Floor 1

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

Analysis: Uniform +X

Check: Chord rotation capacity ( u)

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcwvs

Constant Properties

Knowledge Factor, = 1.00

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

Consequently:

Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 16.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 400.00$

Concrete Elasticity,  $E_c = 21019.039$

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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
Existing material: Steel Strength, fs = 1.25*fsm = 500.00
#####
Total Height, Htot = 3000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 600.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping
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Stepwise Properties
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At local axis: 3
EDGE -A-
Shear Force, Va = -3.6423187E-030
EDGE -B-
Shear Force, Vb = 3.6423187E-030
BOTH EDGES
Axial Force, F = -27514.027
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 6346.017
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 2865.133
-Compression: Asl,com = 2865.133
-Middle: Asl,mid = 0.00
(According to 10.7.2.3 Asl,mid is setted equal to zero)
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Calculation of Shear Capacity ratio , Ve/Vr = 2.25608
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 3.8558E+006
with
Mpr1 = Max(Mu1+ , Mu1-) = 5.7837E+009
Mu1+ = 5.0210E+009, 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- = 5.7837E+009, 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-) = 5.7837E+009
Mu2+ = 5.0210E+009, 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- = 5.7837E+009, 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
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Calculation of Mu1+
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Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.1673539E-005
Mu = 5.0210E+009
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with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi: \phi^* = \text{shear\_factor} * \text{Max}(\phi, \phi_c) = 0.0035$$

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

$$\text{From (5.4b), TB DY: } \phi = 0.0035$$

$$\phi_e (5.4c) = 0.00$$

$$\phi_{se} ((5.4d), \text{TB DY}) = (\phi_{se1} * A_{col1} + \phi_{se2} * A_{col2} + \phi_{se3} * A_{web}) / A_{sec} = 0.00$$

$$\phi_{se1} = 0.00$$

$$s_{h1} = 100.00$$

$$b_{o1} = 190.00$$

$$h_{o1} = 540.00$$

$$b_{i21} = 655400.00$$

$$\phi_{se2} = 0.00$$

$$s_{h2} = 100.00$$

$$b_{o2} = 190.00$$

$$h_{o2} = 540.00$$

$$b_{i22} = 655400.00$$

$$\phi_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$\phi_{sh, \min} = \text{Min}(\phi_{sh, x}, \phi_{sh, y}) = 0.0010472$$

$$\phi_{sh, x} = \phi_{s1, x} + \phi_{s2, x} + \phi_{s3, x} = 0.00439823$$

$$\phi_{s1, x} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00125664$$

$$h_1 = 600.00$$

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

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

$$\phi_{s2, x} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00125664$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\phi_{s3, x} (\text{web}) = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirups, } n_{s3} = 2.00$$

$$\phi_{sh, y} = \phi_{s1, y} + \phi_{s2, y} + \phi_{s3, y} = 0.0010472$$

$$\phi_{s1, y} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.0005236$$

$$h_1 = 250.00$$

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

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

$$\phi_{s2, y} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.0005236$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\phi_{s3, y} (\text{web}) = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

$$\text{No stirups, } n_{s3} = 0.00$$

$$A_{sec} = 750000.00$$

$$s_1 = 100.00$$

$$s_2 = 100.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 500.00$$

$$f_{ce} = 16.00$$

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

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

$$y_1 = 0.00208333$$

$$s_{h1} = 0.00805$$

$$f_{t1} = 600.00$$

$$f_{y1} = 500.00$$

$$s_{u1} = 0.03226667$$

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using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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, ASCE41-17.
with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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, ASCE41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652
2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723
2 = Asl,com/(b*d)*(fs2/fc) = 0.16099723
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.06523978
Mu = MRc (4.14) = 5.0210E+009
u = su (4.1) = 1.1673539E-005

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Calculation of ratio  $l_b/l_d$

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

Calculation of  $\mu_1$ -

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

$$\mu = 1.1958028E-005$$

$$\mu_u = 5.7837E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$\nu = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear\_factor} * \text{Max}(c_u, c_c) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } c_u = 0.0035$$

$$w_e \text{ (5.4c)} = 0.00$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 100.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 100.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.0010472$$

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00439823$$

$$p_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00125664$$

$$h_1 = 600.00$$

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

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

$$p_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00125664$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$p_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirups, } n_{s3} = 2.00$$

$$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.0010472$$

$$p_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.0005236$$

$$h_1 = 250.00$$

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

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

$$p_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.0005236$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$p_{s3,y} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

$$\text{No stirups, } n_{s3} = 0.00$$

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Asec = 750000.00
s_1 = 100.00
s_2 = 100.00
s_3 = 200.00
fywe = 500.00
fce = 16.00
From ((5.A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00208333
sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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, ASCE41-17.
with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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, ASCE41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652
2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652
v = Asl,mid/(b*d)*(fsv/fc) = 0.02602943
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002

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c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723
2 = Asl,com/(b*d)*(fs2/fc) = 0.16099723
v = Asl,mid/(b*d)*(fsv/fc) = 0.03460028
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.8) = 0.08747825
Mu = MRc (4.15) = 5.7837E+009
u = su (4.1) = 1.1958028E-005

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Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

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

u = 1.1673539E-005

Mu = 5.0210E+009

with full section properties:

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b = 250.00
d = 2957.00
d' = 43.00
v = 0.00232618
N = 27514.027
fc = 16.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0035
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0035
we (5.4c) = 0.00
ase ((5.4d), TBDY) = (ase1*Acol1+ase2*Acol2+ase3*Aweb)/Asec = 0.00
ase1 = 0.00
sh_1 = 100.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 100.00
bo_2 = 190.00
ho_2 = 540.00
bi2_2 = 655400.00
ase3 = 0 (grid does not provide confinement)
psh,min = Min(psh,x , psh,y) = 0.0010472

```

```

psh,x = ps1,x+ps2,x+ps3,x = 0.00439823
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00125664
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00125664
h2 = 600.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,x (web) = (As3*h3/s_3)/Ac = 0.00188496
h3 = 1800.00

```

As3 = Astir3\*ns3 = 0.00  
No stirups, ns3 = 2.00

-----  
psh,y = ps1,y+ps2,y+ps3,y = 0.0010472  
ps1,y (column 1) = (As1\*h1/s\_1)/Ac = 0.0005236  
h1 = 250.00  
As1 = Astir1\*ns1 = 157.0796  
No stirups, ns1 = 2.00  
ps2,y (column 2) = (As2\*h2/s\_2)/Ac = 0.0005236  
h2 = 250.00  
As2 = Astir2\*ns2 = 157.0796  
No stirups, ns2 = 2.00  
ps3,y (web) = (As3\*h3/s\_3)/Ac = 0.00  
h3 = 250.00  
As3 = Astir3\*ns3 = 157.0796  
No stirups, ns3 = 0.00  
-----

Asec = 750000.00  
s\_1 = 100.00  
s\_2 = 100.00  
s\_3 = 200.00  
fywe = 500.00  
fce = 16.00

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

y1 = 0.00208333  
sh1 = 0.00805  
ft1 = 600.00  
fy1 = 500.00  
su1 = 0.03226667

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

lo/lou,min = lb/ld = 1.00

su1 = 0.4\*esu1\_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1\_nominal = 0.08066667,

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, ASCE41-17.

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

y2 = 0.00208333  
sh2 = 0.00805  
ft2 = 600.00  
fy2 = 500.00  
su2 = 0.03226667

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

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

su2 = 0.4\*esu2\_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2\_nominal = 0.08066667,

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, ASCE41-17.

with fs2 = fs = 500.00

with Es2 = Es = 200000.00

yv = 0.00208333  
shv = 0.00805  
ftv = 600.00  
fyv = 500.00  
suv = 0.03226667

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

lo/lou,min = lb/ld = 1.00

suv = 0.4\*esuv\_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY:  $esuv\_nominal = 0.08066667$ ,  
 considering characteristic value  $fsv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv\_nominal$  and  $yv, shv, ftv, fyv$ , it is considered  
 characteristic value  $fsv = fsv/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $Min(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE41-17.  
 with  $fsv = fs = 500.00$   
 with  $Esv = Es = 200000.00$   
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652$   
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652$   
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00$

and confined core properties:

$b = 190.00$   
 $d = 2927.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 16.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723$   
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.16099723$   
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00$

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

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

---->  
 $su (4.9) = 0.06523978$   
 $Mu = MRc (4.14) = 5.0210E+009$   
 $u = su (4.1) = 1.1673539E-005$

Calculation of ratio  $lb/ld$

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

Calculation of  $Mu2$ -

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

$u = 1.1958028E-005$   
 $Mu = 5.7837E+009$

with full section properties:

$b = 250.00$   
 $d = 2957.00$   
 $d' = 43.00$   
 $v = 0.00232618$   
 $N = 27514.027$   
 $fc = 16.00$   
 $co (5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.0035$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.0035$   
 $we (5.4c) = 0.00$   
 $ase ((5.4d), TBDY) = (ase1*Acol1 + ase2*Acol2 + ase3*Aweb)/Asec = 0.00$   
 $ase1 = 0.00$   
 $sh\_1 = 100.00$   
 $bo\_1 = 190.00$   
 $ho\_1 = 540.00$   
 $bi2\_1 = 655400.00$   
 $ase2 = 0.00$   
 $sh\_2 = 100.00$   
 $bo\_2 = 190.00$   
 $ho\_2 = 540.00$   
 $bi2\_2 = 655400.00$

ase3 = 0 (grid does not provide confinement)  
psh,min = Min(psh,x , psh,y) = 0.0010472

psh,x = ps1,x+ps2,x+ps3,x = 0.00439823  
ps1,x (column 1) = (As1\*h1/s\_1)/Ac = 0.00125664  
h1 = 600.00  
As1 = Astir1\*ns1 = 157.0796  
No stirups, ns1 = 2.00  
ps2,x (column 2) = (As2\*h2/s\_2)/Ac = 0.00125664  
h2 = 600.00  
As2 = Astir2\*ns2 = 157.0796  
No stirups, ns2 = 2.00  
ps3,x (web) = (As3\*h3/s\_3)/Ac = 0.00188496  
h3 = 1800.00  
As3 = Astir3\*ns3 = 0.00  
No stirups, ns3 = 2.00

psh,y = ps1,y+ps2,y+ps3,y = 0.0010472  
ps1,y (column 1) = (As1\*h1/s\_1)/Ac = 0.0005236  
h1 = 250.00  
As1 = Astir1\*ns1 = 157.0796  
No stirups, ns1 = 2.00  
ps2,y (column 2) = (As2\*h2/s\_2)/Ac = 0.0005236  
h2 = 250.00  
As2 = Astir2\*ns2 = 157.0796  
No stirups, ns2 = 2.00  
ps3,y (web) = (As3\*h3/s\_3)/Ac = 0.00  
h3 = 250.00  
As3 = Astir3\*ns3 = 157.0796  
No stirups, ns3 = 0.00

Asec = 750000.00  
s\_1 = 100.00  
s\_2 = 100.00  
s\_3 = 200.00

fywe = 500.00  
fce = 16.00

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

y1 = 0.00208333  
sh1 = 0.00805

ft1 = 600.00  
fy1 = 500.00

su1 = 0.03226667

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

lo/lou,min = lb/lb = 1.00

su1 = 0.4\*esu1\_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1\_nominal = 0.08066667,

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, ASCE41-17.

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

y2 = 0.00208333  
sh2 = 0.00805

ft2 = 600.00  
fy2 = 500.00

su2 = 0.03226667

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

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

su2 = 0.4\*esu2\_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2\_nominal = 0.08066667,

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, ASCE41-17.  
 with  $fs2 = fs = 500.00$   
 with  $Es2 = Es = 200000.00$   
 $yv = 0.00208333$   
 $shv = 0.00805$   
 $ftv = 600.00$   
 $fyv = 500.00$   
 $suv = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $lo/lou, min = lb/ld = 1.00$   
 $suv = 0.4 \cdot esuv\_nominal ((5.5), TBDY) = 0.03226667$   
 From table 5A.1, TBDY:  $esuv\_nominal = 0.08066667$ ,  
 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, ASCE41-17.  
 with  $fsv = fs = 500.00$   
 with  $Esv = Es = 200000.00$   
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.12111652$   
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.12111652$   
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.02602943$   
 and confined core properties:  
 $b = 190.00$   
 $d = 2927.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 16.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.16099723$   
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.16099723$   
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.03460028$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < vs, y2$  - LHS eq.(4.5) is not satisfied  
 --->  
 $v < vs, c$  - RHS eq.(4.5) is satisfied  
 --->  
 $su (4.8) = 0.08747825$   
 $Mu = MRc (4.15) = 5.7837E+009$   
 $u = su (4.1) = 1.1958028E-005$

Calculation of ratio  $lb/ld$

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

Calculation of Shear Strength  $Vr = \text{Min}(Vr1, Vr2) = 1.7091E+006$

Calculation of Shear Strength at edge 1,  $Vr1 = 1.7091E+006$   
 From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $Vr1 = Vn < 0.83 \cdot fc^{0.5} \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14:  $Vc = 653502.805$   
 $Mu / Vu - lw / 2 = 0.00 \leq 0$   
 $= 1$  (normal-weight concrete)  
 $fc' = 16.00$ , but  $fc^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $h = 250.00$   
 $d = 2400.00$

lw = 3000.00  
Mu = 2.8146476E-010  
Vu = 3.6423187E-030  
Nu = 27514.027

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0556E+006$

$V_{s1} = 301592.895$  is calculated for pseudo-Column 1, with:

d = 480.00  
Av = 157079.633  
s = 100.00  
fy = 400.00

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

$V_{s2} = 301592.895$  is calculated for pseudo-Column 2, with:

d = 480.00  
Av = 157079.633  
s = 100.00  
fy = 400.00

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

$V_{s3} = 452389.342$  is calculated for web, with:

d = 1440.00  
Av = 157079.633  
s = 200.00  
fy = 400.00

$V_{s3}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

bw = 250.00

Calculation of Shear Strength at edge 2,  $V_{r2} = 1.7091E+006$

From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r2} = V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$

$\mu_u / \mu_u - l_w / 2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$ , but  $f_c'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

h = 250.00

d = 2400.00

lw = 3000.00

Mu = 2.8146476E-010

Vu = 3.6423187E-030

Nu = 27514.027

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0556E+006$

$V_{s1} = 301592.895$  is calculated for pseudo-Column 1, with:

d = 480.00  
Av = 157079.633  
s = 100.00  
fy = 400.00

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

$V_{s2} = 301592.895$  is calculated for pseudo-Column 2, with:

d = 480.00  
Av = 157079.633  
s = 100.00  
fy = 400.00

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

$V_{s3} = 452389.342$  is calculated for web, with:

d = 1440.00  
Av = 157079.633  
s = 200.00  
fy = 400.00

$V_{s3}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

bw = 250.00

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcrcws

#### Constant Properties

Knowledge Factor,  $\gamma = 1.00$

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

Consequently:

Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 16.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 400.00$

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

Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 500.00$

#####

Total Height,  $H_{tot} = 3000.00$

Edges Width,  $W_{edg} = 250.00$

Edges Height,  $H_{edg} = 600.00$

Web Width,  $W_{web} = 250.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

#### Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force,  $V_a = -2.0366709E-032$

EDGE -B-

Shear Force,  $V_b = 2.0366709E-032$

BOTH EDGES

Axial Force,  $F = -27514.027$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $A_{st} = 0.00$

-Compression:  $A_{sc} = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $A_{st,ten} = 2368.761$

-Compression:  $A_{st,com} = 2368.761$

-Middle:  $A_{st,mid} = 0.00$

(According to 10.7.2.3  $A_{st,mid}$  is setted equal to zero)

Calculation of Shear Capacity ratio,  $V_e/V_r = 0.23426757$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n = 211972.373$

with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 3.1796E+008$

$M_{u1+} = 2.4327E+008$ , 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

$Mu1- = 3.1796E+008$ , is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

$Mpr2 = \text{Max}(Mu2+, Mu2-) = 3.1796E+008$

$Mu2+ = 2.4327E+008$ , 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

$Mu2- = 3.1796E+008$ , 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

Calculation of  $Mu1+$

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

$\phi_u = 0.00019144$

$Mu = 2.4327E+008$

with full section properties:

$b = 3000.00$

$d = 208.00$

$d' = 42.00$

$v = 0.00275581$

$N = 27514.027$

$f_c = 16.00$

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

Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.0035$

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

From (5.4b), TB DY:  $\phi_u = 0.0035$

we (5.4c)  $= 0.00$

$\phi_{se} ((5.4d), \text{TB DY}) = (\phi_{se1} * A_{col1} + \phi_{se2} * A_{col2} + \phi_{se3} * A_{web}) / A_{sec} = 0.00$

$\phi_{se1} = 0.00$

$sh_1 = 100.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$\phi_{se2} = 0.00$

$sh_2 = 100.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$\phi_{se3} = 0$  (grid does not provide confinement)

$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.0010472$

$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00439823$

$\phi_{s1,x} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00125664$

$h_1 = 600.00$

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

No stirups,  $n_{s1} = 2.00$

$\phi_{s2,x} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00125664$

$h_2 = 600.00$

$A_{s2} = A_{stir2} * n_{s2} = 157.0796$

No stirups,  $n_{s2} = 2.00$

$\phi_{s3,x} (\text{web}) = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$

$h_3 = 1800.00$

$A_{s3} = A_{stir3} * n_{s3} = 0.00$

No stirups,  $n_{s3} = 2.00$

$\phi_{sh,y} = \phi_{s1,y} + \phi_{s2,y} + \phi_{s3,y} = 0.0010472$

$\phi_{s1,y} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.0005236$

$h_1 = 250.00$

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

No stirups,  $n_{s1} = 2.00$

$\phi_{s2,y} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.0005236$

$h_2 = 250.00$

$A_{s2} = A_{stir2} * n_{s2} = 157.0796$

No stirups,  $n_{s2} = 2.00$



$$ps_{3,y}(\text{web}) = (As_3 \cdot h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$As_3 = Astir_3 \cdot ns_3 = 157.0796$$

$$\text{No stirrups, } ns_3 = 0.00$$

$$A_{sec} = 750000.00$$

$$s_1 = 100.00$$

$$s_2 = 100.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 500.00$$

$$f_{ce} = 16.00$$

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

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

$$y_1 = 0.00208333$$

$$sh_1 = 0.00805$$

$$ft_1 = 600.00$$

$$fy_1 = 500.00$$

$$su_1 = 0.03226667$$

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

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

$$su_1 = 0.4 \cdot esu_{1,nominal} ((5.5), \text{TB DY}) = 0.03226667$$

$$\text{From table 5A.1, TB DY: } esu_{1,nominal} = 0.08066667,$$

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

$y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE41-17.

$$\text{with } fs_1 = fs = 500.00$$

$$\text{with } Es_1 = Es = 200000.00$$

$$y_2 = 0.00208333$$

$$sh_2 = 0.00805$$

$$ft_2 = 600.00$$

$$fy_2 = 500.00$$

$$su_2 = 0.03226667$$

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

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

$$su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), \text{TB DY}) = 0.03226667$$

$$\text{From table 5A.1, TB DY: } esu_{2,nominal} = 0.08066667,$$

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, TB DY.

$y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE41-17.

$$\text{with } fs_2 = fs = 500.00$$

$$\text{with } Es_2 = Es = 200000.00$$

$$y_v = 0.00208333$$

$$sh_v = 0.00805$$

$$ft_v = 600.00$$

$$fy_v = 500.00$$

$$suv = 0.03226667$$

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

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

$$suv = 0.4 \cdot esuv_{nominal} ((5.5), \text{TB DY}) = 0.03226667$$

$$\text{From table 5A.1, TB DY: } esuv_{nominal} = 0.08066667,$$

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

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, TB DY.

$y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE41-17.

$$\text{with } fsv = fs = 500.00$$

$$\text{with } Es_v = Es = 200000.00$$

$$1 = Asl, \text{ten} / (b \cdot d) \cdot (fs_1 / f_c) = 0.11862785$$

$$2 = Asl, \text{com} / (b \cdot d) \cdot (fs_2 / f_c) = 0.11862785$$

$$v = Asl, \text{mid} / (b \cdot d) \cdot (fsv / f_c) = 0.00$$

and confined core properties:

$$b = 2940.00$$

```

d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031
2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18965884
Mu = MRc (4.14) = 2.4327E+008
u = su (4.1) = 0.00019144
-----

Calculation of ratio lb/ld
-----
Adequate Lap Length: lb/ld >= 1
-----
-----

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

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 0.00019712
Mu = 3.1796E+008
-----

with full section properties:
b = 3000.00
d = 208.00
d' = 42.00
v = 0.00275581
N = 27514.027
fc = 16.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0035
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0035
we (5.4c) = 0.00
ase ((5.4d), TBDY) = (ase1*Acol1+ase2*Acol2+ase3*Aweb)/Asec = 0.00
ase1 = 0.00
sh_1 = 100.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 100.00
bo_2 = 190.00
ho_2 = 540.00
bi2_2 = 655400.00
ase3 = 0 (grid does not provide confinement)
psh,min = Min(psh,x , psh,y) = 0.0010472
-----

psh,x = ps1,x+ps2,x+ps3,x = 0.00439823
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00125664
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00125664
h2 = 600.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00

```

$ps3,x \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00188496$   
 $h3 = 1800.00$   
 $As3 = Astir3 \cdot ns3 = 0.00$   
 No stirups,  $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.0010472$   
 $ps1,y \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.0005236$   
 $h1 = 250.00$   
 $As1 = Astir1 \cdot ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.0005236$   
 $h2 = 250.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,y \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 \cdot ns3 = 157.0796$   
 No stirups,  $ns3 = 0.00$

$Asec = 750000.00$   
 $s_1 = 100.00$   
 $s_2 = 100.00$   
 $s_3 = 200.00$

$fywe = 500.00$   
 $fce = 16.00$

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

$y1 = 0.00208333$

$sh1 = 0.00805$

$ft1 = 600.00$

$fy1 = 500.00$

$su1 = 0.03226667$

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

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

$su1 = 0.4 \cdot esu1\_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fs1 = fs = 500.00$

with  $Es1 = Es = 200000.00$

$y2 = 0.00208333$

$sh2 = 0.00805$

$ft2 = 600.00$

$fy2 = 500.00$

$su2 = 0.03226667$

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

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

$su2 = 0.4 \cdot esu2\_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fs2 = fs = 500.00$

with  $Es2 = Es = 200000.00$

$yv = 0.00208333$

$shv = 0.00805$

$ftv = 600.00$

$fyv = 500.00$

$suv = 0.03226667$

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

$l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $suv = 0.4 * esuv\_nominal ((5.5), TBDY) = 0.03226667$   
 From table 5A.1, TBDY:  $esuv\_nominal = 0.08066667$ ,  
 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, ASCE41-17.  
 with  $fsv = fs = 500.00$   
 with  $Esv = Es = 200000.00$   
 $1 = A_{sl,ten}/(b*d) * (fs_1/fc) = 0.11862785$   
 $2 = A_{sl,com}/(b*d) * (fs_2/fc) = 0.11862785$   
 $v = A_{sl,mid}/(b*d) * (fsv/fc) = 0.08055366$   
 and confined core properties:  
 $b = 2940.00$   
 $d = 178.00$   
 $d' = 12.00$   
 $f_{cc} (5A.2, TBDY) = 16.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten}/(b*d) * (fs_1/fc) = 0.14145031$   
 $2 = A_{sl,com}/(b*d) * (fs_2/fc) = 0.14145031$   
 $v = A_{sl,mid}/(b*d) * (fsv/fc) = 0.09605114$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' does not satisfy Eq. (4.3)  
 --->  
 $v < v_{s,c}$  - RHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.2130262$   
 $Mu = MRc (4.14) = 3.1796E+008$   
 $u = su (4.1) = 0.00019712$

Calculation of ratio  $l_b/l_d$

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

Calculation of  $Mu_{2+}$

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

$u = 0.00019144$   
 $Mu = 2.4327E+008$

with full section properties:

$b = 3000.00$   
 $d = 208.00$   
 $d' = 42.00$   
 $v = 0.00275581$   
 $N = 27514.027$   
 $fc = 16.00$   
 $co (5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.0035$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.0035$   
 $we (5.4c) = 0.00$   
 $ase ((5.4d), TBDY) = (ase1 * A_{col1} + ase2 * A_{col2} + ase3 * A_{web}) / A_{sec} = 0.00$   
 $ase1 = 0.00$   
 $sh_1 = 100.00$   
 $bo_1 = 190.00$   
 $ho_1 = 540.00$   
 $bi2_1 = 655400.00$   
 $ase2 = 0.00$   
 $sh_2 = 100.00$   
 $bo_2 = 190.00$

$ho\_2 = 540.00$   
 $bi2\_2 = 655400.00$   
ase3 = 0 (grid does not provide confinement)  
 $psh,min = \text{Min}(psh,x, psh,y) = 0.0010472$

$psh,x = ps1,x + ps2,x + ps3,x = 0.00439823$   
 $ps1,x \text{ (column 1)} = (As1 \cdot h1 / s\_1) / Ac = 0.00125664$   
 $h1 = 600.00$   
 $As1 = Astir1 \cdot ns1 = 157.0796$   
No stirups,  $ns1 = 2.00$   
 $ps2,x \text{ (column 2)} = (As2 \cdot h2 / s\_2) / Ac = 0.00125664$   
 $h2 = 600.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
No stirups,  $ns2 = 2.00$   
 $ps3,x \text{ (web)} = (As3 \cdot h3 / s\_3) / Ac = 0.00188496$   
 $h3 = 1800.00$   
 $As3 = Astir3 \cdot ns3 = 0.00$   
No stirups,  $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.0010472$   
 $ps1,y \text{ (column 1)} = (As1 \cdot h1 / s\_1) / Ac = 0.0005236$   
 $h1 = 250.00$   
 $As1 = Astir1 \cdot ns1 = 157.0796$   
No stirups,  $ns1 = 2.00$   
 $ps2,y \text{ (column 2)} = (As2 \cdot h2 / s\_2) / Ac = 0.0005236$   
 $h2 = 250.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
No stirups,  $ns2 = 2.00$   
 $ps3,y \text{ (web)} = (As3 \cdot h3 / s\_3) / Ac = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 \cdot ns3 = 157.0796$   
No stirups,  $ns3 = 0.00$

$Asec = 750000.00$   
 $s\_1 = 100.00$   
 $s\_2 = 100.00$   
 $s\_3 = 200.00$   
 $fywe = 500.00$   
 $fce = 16.00$   
From ((5.A5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $y1 = 0.00208333$   
 $sh1 = 0.00805$   
 $ft1 = 600.00$   
 $fy1 = 500.00$   
 $su1 = 0.03226667$   
using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou,min = lb/l_d = 1.00$   
 $su1 = 0.4 \cdot esu1\_nominal \text{ ((5.5), TBDY)} = 0.03226667$   
From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,  
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, ASCE41-17.  
with  $fs1 = fs = 500.00$   
with  $Es1 = Es = 200000.00$   
 $y2 = 0.00208333$   
 $sh2 = 0.00805$   
 $ft2 = 600.00$   
 $fy2 = 500.00$   
 $su2 = 0.03226667$   
using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou,min = lb/l_b,min = 1.00$   
 $su2 = 0.4 \cdot esu2\_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08066667$ ,  
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  $Min(1, 1.25 \cdot (lb/d)^{2/3})$ , from 10.3.5, ASCE41-17.  
with  $fs2 = fs = 500.00$   
with  $Es2 = Es = 200000.00$   
 $yv = 0.00208333$   
 $shv = 0.00805$   
 $ftv = 600.00$   
 $fyv = 500.00$   
 $suv = 0.03226667$   
using (30) in Biskinis/Fardis (2013) multiplied with  $shear\_factor$   
and also multiplied by the  $shear\_factor$  according to 15.7.1.4, with  
 $Shear\_factor = 1.00$   
 $lo/lou, min = lb/d = 1.00$   
 $suv = 0.4 \cdot esuv\_nominal \cdot ((5.5), TBDY) = 0.03226667$   
From table 5A.1, TBDY:  $esuv\_nominal = 0.08066667$ ,  
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  $Min(1, 1.25 \cdot (lb/d)^{2/3})$ , from 10.3.5, ASCE41-17.  
with  $fsv = fs = 500.00$   
with  $Es = Es = 200000.00$   
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.11862785$   
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.11862785$   
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00$   
and confined core properties:  
 $b = 2940.00$   
 $d = 178.00$   
 $d' = 12.00$   
 $fcc (5A.2, TBDY) = 16.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.14145031$   
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.14145031$   
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00$   
Case/Assumption: Unconfined full section - Steel rupture  
' does not satisfy Eq. (4.3)  
--->  
 $v < vs, c$  - RHS eq.(4.5) is satisfied  
--->  
 $su (4.9) = 0.18965884$   
 $Mu = MRc (4.14) = 2.4327E+008$   
 $u = su (4.1) = 0.00019144$

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

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

Calculation of  $Mu2$ -  
-----  
-----

-----  
Calculation of ultimate curvature  $u$  according to 4.1, Biskinis/Fardis 2013:  
 $u = 0.00019712$   
 $Mu = 3.1796E+008$   
-----

with full section properties:

$b = 3000.00$   
 $d = 208.00$   
 $d' = 42.00$   
 $v = 0.00275581$   
 $N = 27514.027$   
 $fc = 16.00$

$co$  (5A.5, TBDY) = 0.002  
 Final value of  $cu$ :  $cu^* = shear\_factor * Max(cu, cc) = 0.0035$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.0035$   
 $we$  (5.4c) = 0.00  
 $ase$  ((5.4d), TBDY) =  $(ase1 * Acol1 + ase2 * Acol2 + ase3 * Aweb) / Asec = 0.00$   
 $ase1 = 0.00$   
 $sh\_1 = 100.00$   
 $bo\_1 = 190.00$   
 $ho\_1 = 540.00$   
 $bi2\_1 = 655400.00$   
 $ase2 = 0.00$   
 $sh\_2 = 100.00$   
 $bo\_2 = 190.00$   
 $ho\_2 = 540.00$   
 $bi2\_2 = 655400.00$   
 $ase3 = 0$  (grid does not provide confinement)  
 $psh,min = Min(psh,x, psh,y) = 0.0010472$

$psh,x = ps1,x + ps2,x + ps3,x = 0.00439823$   
 $ps1,x$  (column 1) =  $(As1 * h1 / s\_1) / Ac = 0.00125664$   
 $h1 = 600.00$   
 $As1 = Astir1 * ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,x$  (column 2) =  $(As2 * h2 / s\_2) / Ac = 0.00125664$   
 $h2 = 600.00$   
 $As2 = Astir2 * ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,x$  (web) =  $(As3 * h3 / s\_3) / Ac = 0.00188496$   
 $h3 = 1800.00$   
 $As3 = Astir3 * ns3 = 0.00$   
 No stirups,  $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.0010472$   
 $ps1,y$  (column 1) =  $(As1 * h1 / s\_1) / Ac = 0.0005236$   
 $h1 = 250.00$   
 $As1 = Astir1 * ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,y$  (column 2) =  $(As2 * h2 / s\_2) / Ac = 0.0005236$   
 $h2 = 250.00$   
 $As2 = Astir2 * ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,y$  (web) =  $(As3 * h3 / s\_3) / Ac = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 * ns3 = 157.0796$   
 No stirups,  $ns3 = 0.00$

$Asec = 750000.00$   
 $s\_1 = 100.00$   
 $s\_2 = 100.00$   
 $s\_3 = 200.00$   
 $fywe = 500.00$   
 $fce = 16.00$   
 From ((5.A5), TBDY), TBDY:  $cc = 0.002$   
 $c =$  confinement factor = 1.00  
 $y1 = 0.00208333$   
 $sh1 = 0.00805$   
 $ft1 = 600.00$   
 $fy1 = 500.00$   
 $su1 = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $lo/lou,min = lb/d = 1.00$   
 $su1 = 0.4 * esu1\_nominal$  ((5.5), TBDY) = 0.03226667  
 From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,  
 For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered

characteristic value  $f_{sy1} = f_{s1}/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE41-17.  
 with  $f_{s1} = f_s = 500.00$   
 with  $E_{s1} = E_s = 200000.00$   
 $y2 = 0.00208333$   
 $sh2 = 0.00805$   
 $ft2 = 600.00$   
 $fy2 = 500.00$   
 $su2 = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $l_o/l_{o,min} = l_b/l_{b,min} = 1.00$   
 $su2 = 0.4 \cdot esu2_{nominal} ((5.5), TBDY) = 0.03226667$   
 From table 5A.1, TBDY:  $esu2_{nominal} = 0.08066667$ ,  
 For calculation of  $esu2_{nominal}$  and  $y2, sh2, ft2, fy2$ , it is considered  
 characteristic value  $f_{sy2} = f_{s2}/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE41-17.  
 with  $f_{s2} = f_s = 500.00$   
 with  $E_{s2} = E_s = 200000.00$   
 $yv = 0.00208333$   
 $shv = 0.00805$   
 $ftv = 600.00$   
 $fyv = 500.00$   
 $suv = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $l_o/l_{o,min} = l_b/l_d = 1.00$   
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.03226667$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08066667$ ,  
 considering characteristic value  $f_{syv} = f_{sv}/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $yv, shv, ftv, fyv$ , it is considered  
 characteristic value  $f_{syv} = f_{sv}/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE41-17.  
 with  $f_{sv} = f_s = 500.00$   
 with  $E_{sv} = E_s = 200000.00$   
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.11862785$   
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.11862785$   
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.08055366$   
 and confined core properties:  
 $b = 2940.00$   
 $d = 178.00$   
 $d' = 12.00$   
 $f_{cc} (5A.2, TBDY) = 16.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.14145031$   
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.14145031$   
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.09605114$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' does not satisfy Eq. (4.3)  
 --->  
 $v < v_{s,c}$  - RHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.2130262$   
 $M_u = M_{Rc} (4.14) = 3.1796E+008$   
 $u = su (4.1) = 0.00019712$

Calculation of ratio  $l_b/l_d$

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



Calculation of Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 904830.218$

Calculation of Shear Strength at edge 1,  $V_{r1} = 904830.218$

From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r1} = V_n < 0.83 \cdot f_c'^{0.5} \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$

$\mu_u / \mu - l_w / 2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$ , but  $f_c'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$\mu_u = 2.0446822\text{E-}012$

$V_u = 2.0366709\text{E-}032$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 251327.412$

$V_{s1} = 125663.706$  is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s2} = 125663.706$  is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s3} = 0.00$  is calculated for web, with:

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 400.00$

$V_{s3}$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943\text{E}+006$

$b_w = 3000.00$

Calculation of Shear Strength at edge 2,  $V_{r2} = 904830.218$

From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r2} = V_n < 0.83 \cdot f_c'^{0.5} \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$

$\mu_u / \mu - l_w / 2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$ , but  $f_c'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$\mu_u = 2.0446822\text{E-}012$

$V_u = 2.0366709\text{E-}032$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 251327.412$

$V_{s1} = 125663.706$  is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s2} = 125663.706$  is calculated for pseudo-Column 2, with:

$d = 200.00$

$$A_v = 157079.633$$

$$s = 100.00$$

$$f_y = 400.00$$

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

Vs3 = 0.00 is calculated for web, with:

$$d = 200.00$$

$$A_v = 0.00$$

$$s = 200.00$$

$$f_y = 400.00$$

Vs3 has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.00$$

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

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 1.5943E+006$$

$$b_w = 3000.00$$

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcrrws

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

According to 10.7.2.3, ASCE 41-17, shear walls with

transverse reinforcement percentage,  $\rho_t < 0.0015$

are considered Force-Controlled and lower-bound strengths are used according to 7.5.1.3, ASCE 41-17

$$\rho_t = 0.0010472$$

with  $\rho_t = \rho_{t1} + \rho_{t2} + \rho_{t3}$ , being the shear reinf. ratio in a plane perpendicular to the shear axis 3

$$(\text{pseudo-col.1 } \rho_{t1} = A_{s1} \cdot b_1 / s_1 = (A_{s1} \cdot h_1 / s_1) / A_c = 0.0005236$$

$$h_1 = 250.00$$

$$s_1 = 100.00$$

$$\text{total area of hoops perpendicular to shear axis, } A_{s1} = 157.0796$$

$$(\text{pseudo-col.2 } \rho_{t2} = A_{s2} \cdot b_2 / s_2 = (A_{s2} \cdot h_2 / s_2) / A_c = 0.0005236$$

$$h_2 = 250.00$$

$$s_2 = 100.00$$

$$\text{total area of hoops perpendicular to shear axis, } A_{s2} = 157.0796$$

$$(\text{grid } \rho_{t3} = A_{s3} \cdot b_3 / s_3 = (A_{s3} \cdot h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$s_3 = 200.00$$

$$\text{total area of hoops perpendicular to shear axis, } A_{s3} = 0.00$$

$$\text{total section area, } A_c = 750000.00$$

Consequently:

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,  $E_s = 200000.00$

Total Height,  $H_{tot} = 3000.00$

Edges Width,  $W_{edg} = 250.00$

Edges Height,  $H_{edg} = 600.00$

Web Width,  $W_{web} = 250.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

### Stepwise Properties

Axial Force,  $F = -27598.912$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $A_{st} = 0.00$

-Compression:  $A_{sc} = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $A_{st,ten} = 2865.133$

-Compression:  $A_{sc,com} = 2865.133$

-Middle:  $A_{st,mid} = 615.7522$

Mean Diameter of Tension Reinforcement,  $D_bL = 17.33333$

Considering wall controlled by Shear (shear control ratio  $> 1$ ),  
interstorey drift provided values are calculated

Existing component: From table 7-7, ASCE 41\_17: Final interstorey drift Capacity  $u_{i,R} = \dots$   $u = 0.004$   
from table 10-20:  $u = 0.004$

with:

- Condition i (shear wall and wall segments)

-  $(A_s - A_s') \cdot f_y + P) / (t_w \cdot l_w \cdot f_c') = -0.209234$

$A_s = 0.00$

$A_s' = 6346.017$

$f_y = 400.00$

$P = 27598.912$

$t_w = 250.00$

$l_w = 3000.00$

$f_c = 16.00$

End Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (a)

## Calculation No. 3

wall W1, Floor 1

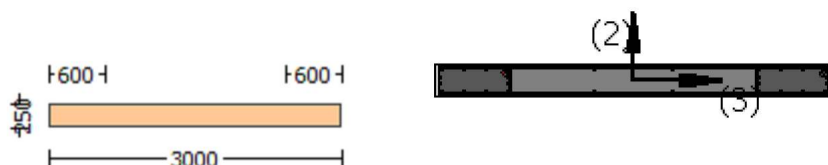
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity  $VR_d$

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcrws

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.

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

Consequently:

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,  $E_s = 200000.00$

Total Height,  $H_{tot} = 3000.00$

Edges Width,  $W_{edg} = 250.00$

Edges Height,  $H_{edg} = 600.00$

Web Width,  $W_{web} = 250.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment,  $M_a = 7.6264E+007$

Shear Force,  $V_a = -25423.336$

EDGE -B-

Bending Moment,  $M_b = 14301.377$

Shear Force,  $V_b = 25423.336$

BOTH EDGES

Axial Force,  $F = -27598.912$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $A_{sl,t} = 0.00$

-Compression:  $A_{sl,c} = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $A_{sl,ten} = 2865.133$

-Compression:  $A_{sl,com} = 2865.133$

-Middle:  $A_{sl,mid} = 615.7522$

Mean Diameter of Tension Reinforcement,  $Db_{L,ten} = 17.33333$

Existing component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $V_R = V_n = 1.6645E+006$   
From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_n < 0.83 \cdot f_c'^{0.5} \cdot h \cdot d = 1.6645E+006$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 608913.747$   
 $\mu_u / \mu_u - l_w / 2 = 1499.748 > 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$ , but  $f_c'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 7.6264E+007$

$V_u = 25423.336$

$N_u = 27598.912$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0556E+006$

$V_{s1} = 301592.895$  is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s2} = 301592.895$  is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s3} = 452389.342$  is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 400.00$

$V_{s3}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

$b_w = 250.00$

End Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (a)

## Calculation No. 4

wall W1, Floor 1

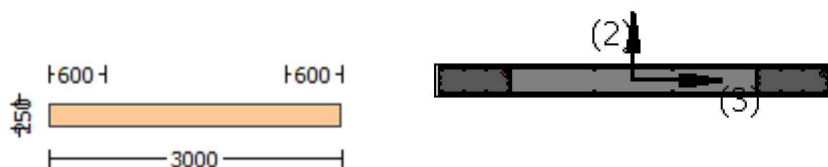
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (  $\mu$  )

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcwrs

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

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

Consequently:

Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 16.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 400.00$

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

Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 500.00$

#####

Total Height,  $H_{tot} = 3000.00$

Edges Width,  $W_{edg} = 250.00$

Edges Height,  $H_{edg} = 600.00$

Web Width,  $W_{web} = 250.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force,  $V_a = -3.6423187E-030$

EDGE -B-

Shear Force,  $V_b = 3.6423187E-030$

BOTH EDGES

Axial Force,  $F = -27514.027$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $A_{sl,t} = 0.00$

-Compression:  $A_{sl,c} = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $A_{sl,ten} = 2865.133$

-Compression:  $A_{sl,com} = 2865.133$

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

(According to 10.7.2.3  $A_{sl,mid}$  is setted equal to zero)

Calculation of Shear Capacity ratio ,  $V_e/V_r = 2.25608$

Member Controlled by Shear ( $V_e/V_r > 1$ )

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n = 3.8558E+006$   
with

$M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 5.7837E+009$

$\mu_{u1+} = 5.0210E+009$ , 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

$\mu_{u1-} = 5.7837E+009$ , 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

$M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 5.7837E+009$

$\mu_{u2+} = 5.0210E+009$ , 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

$\mu_{u2-} = 5.7837E+009$ , 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

Calculation of  $\mu_{u1+}$

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

$\mu_u = 1.1673539E-005$

$\mu_u = 5.0210E+009$

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$

$v = 0.00232618$

$N = 27514.027$

$f_c = 16.00$

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

Final value of  $\phi_{cu}$ :  $\phi_{cu}^* = \text{shear\_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0035$

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

From (5.4b), TBDY:  $\phi_{cu} = 0.0035$

$\phi_{we}$  (5.4c) = 0.00

$\phi_{ase}$  ((5.4d), TBDY) =  $(\phi_{ase1} * A_{col1} + \phi_{ase2} * A_{col2} + \phi_{ase3} * A_{web}) / A_{sec} = 0.00$

$\phi_{ase1} = 0.00$

$sh_1 = 100.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$\phi_{ase2} = 0.00$

$sh_2 = 100.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$\phi_{ase3} = 0$  (grid does not provide confinement)

$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.0010472$

$\phi_{psh,x} = \phi_{ps1,x} + \phi_{ps2,x} + \phi_{ps3,x} = 0.00439823$

$\phi_{ps1,x}$  (column 1) =  $(A_{s1} * h_1 / s_1) / A_c = 0.00125664$

$h_1 = 600.00$

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

No stirups,  $n_{s1} = 2.00$

$\phi_{ps2,x}$  (column 2) =  $(A_{s2} * h_2 / s_2) / A_c = 0.00125664$

$h_2 = 600.00$

$A_{s2} = A_{stir2} * n_{s2} = 157.0796$

No stirups,  $n_{s2} = 2.00$

$\phi_{ps3,x}$  (web) =  $(A_{s3} * h_3 / s_3) / A_c = 0.00188496$

$h_3 = 1800.00$

$A_{s3} = A_{stir3} * n_{s3} = 0.00$

No stirups,  $n_{s3} = 2.00$

```

psh,y = ps1,y+ps2,y+ps3,y = 0.0010472
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.0005236
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.0005236
h2 = 250.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
h3 = 250.00
As3 = Astir3*ns3 = 157.0796
No stirups, ns3 = 0.00

```

```

Asec = 750000.00

```

```

s_1 = 100.00

```

```

s_2 = 100.00

```

```

s_3 = 200.00

```

```

fywe = 500.00

```

```

fce = 16.00

```

```

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

```

```

c = confinement factor = 1.00

```

```

y1 = 0.00208333

```

```

sh1 = 0.00805

```

```

ft1 = 600.00

```

```

fy1 = 500.00

```

```

su1 = 0.03226667

```

```

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

```

```

lo/lou,min = lb/ld = 1.00

```

```

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

```

```

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

```

```

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, ASCE41-17.

```

```

with fs1 = fs = 500.00

```

```

with Es1 = Es = 200000.00

```

```

y2 = 0.00208333

```

```

sh2 = 0.00805

```

```

ft2 = 600.00

```

```

fy2 = 500.00

```

```

su2 = 0.03226667

```

```

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

```

```

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

```

```

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

```

```

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

```

```

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, ASCE41-17.

```

```

with fs2 = fs = 500.00

```

```

with Es2 = Es = 200000.00

```

```

yv = 0.00208333

```

```

shv = 0.00805

```

```

ftv = 600.00

```

```

fyv = 500.00

```

```

suv = 0.03226667

```

```

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

```

```

lo/lou,min = lb/ld = 1.00

```

```

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667

```

```

From table 5A.1, TBDY: esuv_nominal = 0.08066667,

```

```

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

```



For calculation of  $\epsilon_{sv\_nominal}$  and  $\gamma_v$ ,  $\Delta v$ ,  $\Delta f_v$ ,  $\Delta f_{yv}$ , it is considered characteristic value  $f_{sv} = f_{sv}/1.2$ , from table 5.1, TBDY.

$\gamma_1$ ,  $\Delta v_1$ ,  $\Delta f_{v1}$ ,  $\Delta f_{yv1}$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE41-17.

with  $f_{sv} = f_s = 500.00$

with  $E_{sv} = E_s = 200000.00$

$1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.12111652$

$2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.12111652$

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$

and confined core properties:

$b = 190.00$

$d = 2927.00$

$d' = 13.00$

$f_{cc} \text{ (5A.2, TBDY)} = 16.00$

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

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

$1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.16099723$

$2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.16099723$

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$\mu_u \text{ (4.9)} = 0.06523978$

$\mu_u = M_{Rc} \text{ (4.14)} = 5.0210E+009$

$u = \mu_u \text{ (4.1)} = 1.1673539E-005$

Calculation of ratio  $l_b/l_d$

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

Calculation of  $\mu_{u1}$ -

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

$u = 1.1958028E-005$

$\mu_u = 5.7837E+009$

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$

$v = 0.00232618$

$N = 27514.027$

$f_c = 16.00$

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

Final value of  $\mu_u$ :  $\mu_u^* = \text{shear\_factor} \cdot \text{Max}(\mu_u, cc) = 0.0035$

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

From (5.4b), TBDY:  $\mu_u = 0.0035$

$w_e \text{ (5.4c)} = 0.00$

$ase \text{ ((5.4d), TBDY)} = (ase1 \cdot A_{col1} + ase2 \cdot A_{col2} + ase3 \cdot A_{web})/A_{sec} = 0.00$

$ase1 = 0.00$

$sh_1 = 100.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$ase2 = 0.00$

$sh_2 = 100.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$ase3 = 0 \text{ (grid does not provide confinement)}$

$psh_{min} = \text{Min}(psh_x, psh_y) = 0.0010472$

```

psh,x = ps1,x+ps2,x+ps3,x = 0.00439823
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00125664
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00125664
h2 = 600.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,x (web) = (As3*h3/s_3)/Ac = 0.00188496
h3 = 1800.00
As3 = Astir3*ns3 = 0.00
No stirups, ns3 = 2.00

```

```

psh,y = ps1,y+ps2,y+ps3,y = 0.0010472
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.0005236
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.0005236
h2 = 250.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
h3 = 250.00
As3 = Astir3*ns3 = 157.0796
No stirups, ns3 = 0.00

```

```

Asec = 750000.00
s_1 = 100.00
s_2 = 100.00
s_3 = 200.00
fywe = 500.00
fce = 16.00

```

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

```

y1 = 0.00208333
sh1 = 0.00805

```

```

ft1 = 600.00
fy1 = 500.00

```

```

su1 = 0.03226667

```

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

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

su1 = 0.4\*esu1\_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1\_nominal = 0.08066667,

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, ASCE41-17.

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

```

y2 = 0.00208333
sh2 = 0.00805

```

```

ft2 = 600.00
fy2 = 500.00

```

```

su2 = 0.03226667

```

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

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

su2 = 0.4\*esu2\_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2\_nominal = 0.08066667,

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

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25\*(lb/lb,min)^ 2/3), from 10.3.5, ASCE41-17.

```

with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652
2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652
v = Asl,mid/(b*d)*(fsv/fc) = 0.02602943
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723
2 = Asl,com/(b*d)*(fs2/fc) = 0.16099723
v = Asl,mid/(b*d)*(fsv/fc) = 0.03460028
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.8) = 0.08747825
Mu = MRc (4.15) = 5.7837E+009
u = su (4.1) = 1.1958028E-005

```

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu2+

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

u = 1.1673539E-005  
Mu = 5.0210E+009

with full section properties:

```

b = 250.00
d = 2957.00
d' = 43.00
v = 0.00232618
N = 27514.027
fc = 16.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0035

```

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

From (5.4b), TBDY:  $c_u = 0.0035$

$w_e$  (5.4c) = 0.00

$a_{se}$  ((5.4d), TBDY) =  $(a_{se1} \cdot A_{col1} + a_{se2} \cdot A_{col2} + a_{se3} \cdot A_{web}) / A_{sec} = 0.00$

$a_{se1} = 0.00$

$sh_1 = 100.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$a_{se2} = 0.00$

$sh_2 = 100.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$a_{se3} = 0$  (grid does not provide confinement)

$psh_{min} = \min(psh_x, psh_y) = 0.0010472$

$psh_x = ps1_x + ps2_x + ps3_x = 0.00439823$

$ps1_x$  (column 1) =  $(As1 \cdot h1 / s_1) / A_c = 0.00125664$

$h1 = 600.00$

$As1 = Astir1 \cdot ns1 = 157.0796$

No stirups,  $ns1 = 2.00$

$ps2_x$  (column 2) =  $(As2 \cdot h2 / s_2) / A_c = 0.00125664$

$h2 = 600.00$

$As2 = Astir2 \cdot ns2 = 157.0796$

No stirups,  $ns2 = 2.00$

$ps3_x$  (web) =  $(As3 \cdot h3 / s_3) / A_c = 0.00188496$

$h3 = 1800.00$

$As3 = Astir3 \cdot ns3 = 0.00$

No stirups,  $ns3 = 2.00$

$psh_y = ps1_y + ps2_y + ps3_y = 0.0010472$

$ps1_y$  (column 1) =  $(As1 \cdot h1 / s_1) / A_c = 0.0005236$

$h1 = 250.00$

$As1 = Astir1 \cdot ns1 = 157.0796$

No stirups,  $ns1 = 2.00$

$ps2_y$  (column 2) =  $(As2 \cdot h2 / s_2) / A_c = 0.0005236$

$h2 = 250.00$

$As2 = Astir2 \cdot ns2 = 157.0796$

No stirups,  $ns2 = 2.00$

$ps3_y$  (web) =  $(As3 \cdot h3 / s_3) / A_c = 0.00$

$h3 = 250.00$

$As3 = Astir3 \cdot ns3 = 157.0796$

No stirups,  $ns3 = 0.00$

$A_{sec} = 750000.00$

$s_1 = 100.00$

$s_2 = 100.00$

$s_3 = 200.00$

$fy_{we} = 500.00$

$f_{ce} = 16.00$

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

$c$  = confinement factor = 1.00

$y1 = 0.00208333$

$sh1 = 0.00805$

$ft1 = 600.00$

$fy1 = 500.00$

$su1 = 0.03226667$

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

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

$su1 = 0.4 \cdot esu1_{nominal}$  ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY:  $esu1_{nominal} = 0.08066667$ ,

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  $\min(1, 1.25 \cdot (lb/l_d)^{2/3})$ , from 10.3.5, ASCE41-17.

```

with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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, ASCE41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652
2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723
2 = Asl,com/(b*d)*(fs2/fc) = 0.16099723
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.06523978
Mu = MRc (4.14) = 5.0210E+009
u = su (4.1) = 1.1673539E-005

```

Calculation of ratio lb/lb

Adequate Lap Length: lb/lb >= 1

Calculation of Mu2-

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

$$\phi_u = 1.1958028E-005$$

$$\mu = 5.7837E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$\nu = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear\_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.0035$$

$$\phi_{we} (5.4c) = 0.00$$

$$\phi_{ase} ((5.4d), TBDY) = (\phi_{ase1} * A_{col1} + \phi_{ase2} * A_{col2} + \phi_{ase3} * A_{web}) / A_{sec} = 0.00$$

$$\phi_{ase1} = 0.00$$

$$s_{h\_1} = 100.00$$

$$b_{o\_1} = 190.00$$

$$h_{o\_1} = 540.00$$

$$b_{i2\_1} = 655400.00$$

$$\phi_{ase2} = 0.00$$

$$s_{h\_2} = 100.00$$

$$b_{o\_2} = 190.00$$

$$h_{o\_2} = 540.00$$

$$b_{i2\_2} = 655400.00$$

$$\phi_{ase3} = 0 \text{ (grid does not provide confinement)}$$

$$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.0010472$$

$$\phi_{psh,x} = \phi_{ps1,x} + \phi_{ps2,x} + \phi_{ps3,x} = 0.00439823$$

$$\phi_{ps1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_{h\_1}) / A_c = 0.00125664$$

$$h_1 = 600.00$$

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

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

$$\phi_{ps2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_{h\_2}) / A_c = 0.00125664$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\phi_{ps3,x} \text{ (web)} = (A_{s3} * h_3 / s_{h\_3}) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirups, } n_{s3} = 2.00$$

$$\phi_{psh,y} = \phi_{ps1,y} + \phi_{ps2,y} + \phi_{ps3,y} = 0.0010472$$

$$\phi_{ps1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_{h\_1}) / A_c = 0.0005236$$

$$h_1 = 250.00$$

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

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

$$\phi_{ps2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_{h\_2}) / A_c = 0.0005236$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\phi_{ps3,y} \text{ (web)} = (A_{s3} * h_3 / s_{h\_3}) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

$$\text{No stirups, } n_{s3} = 0.00$$

$$A_{sec} = 750000.00$$

$$s_{h\_1} = 100.00$$

$$s_{h\_2} = 100.00$$

$$s_{h\_3} = 200.00$$

$$f_{ywe} = 500.00$$

$$f_{ce} = 16.00$$

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

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

```

y1 = 0.00208333
sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 1.00
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
    From table 5A.1, TBDY: esu1_nominal = 0.08066667,
    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, ASCE41-17.
    with fs1 = fs = 500.00
    with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 1.00
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
    From table 5A.1, TBDY: esu2_nominal = 0.08066667,
    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, ASCE41-17.
    with fs2 = fs = 500.00
    with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 1.00
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
    From table 5A.1, TBDY: esuv_nominal = 0.08066667,
    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, ASCE41-17.
    with fsv = fs = 500.00
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652
2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652
v = Asl,mid/(b*d)*(fsv/fc) = 0.02602943
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723
2 = Asl,com/(b*d)*(fs2/fc) = 0.16099723
v = Asl,mid/(b*d)*(fsv/fc) = 0.03460028
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
---->
v < vs,y2 - LHS eq.(4.5) is not satisfied
---->

```

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

--->

$$\mu_u (4.8) = 0.08747825$$

$$\mu_u = M R_c (4.15) = 5.7837E+009$$

$$u = \mu_u (4.1) = 1.1958028E-005$$

Calculation of ratio  $l_b/l_d$

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

Calculation of Shear Strength  $V_r = \min(V_{r1}, V_{r2}) = 1.7091E+006$

Calculation of Shear Strength at edge 1,  $V_{r1} = 1.7091E+006$

From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r1} = V_n < 0.83 \cdot f_c' \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$

$$\mu_u / V_u - l_w / 2 = 0.00 \leq 0$$

= 1 (normal-weight concrete)

$$f_c' = 16.00, \text{ but } f_c'^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$h = 250.00$$

$$d = 2400.00$$

$$l_w = 3000.00$$

$$\mu_u = 2.8146476E-010$$

$$V_u = 3.6423187E-030$$

$$N_u = 27514.027$$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0556E+006$

$V_{s1} = 301592.895$  is calculated for pseudo-Column 1, with:

$$d = 480.00$$

$$A_v = 157079.633$$

$$s = 100.00$$

$$f_y = 400.00$$

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

$V_{s2} = 301592.895$  is calculated for pseudo-Column 2, with:

$$d = 480.00$$

$$A_v = 157079.633$$

$$s = 100.00$$

$$f_y = 400.00$$

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

$V_{s3} = 452389.342$  is calculated for web, with:

$$d = 1440.00$$

$$A_v = 157079.633$$

$$s = 200.00$$

$$f_y = 400.00$$

$V_{s3}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

$$b_w = 250.00$$

Calculation of Shear Strength at edge 2,  $V_{r2} = 1.7091E+006$

From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r2} = V_n < 0.83 \cdot f_c' \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$

$$\mu_u / V_u - l_w / 2 = 0.00 \leq 0$$

= 1 (normal-weight concrete)

$$f_c' = 16.00, \text{ but } f_c'^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$h = 250.00$$

$$d = 2400.00$$



$lw = 3000.00$   
 $Mu = 2.8146476E-010$   
 $Vu = 3.6423187E-030$   
 $Nu = 27514.027$   
 From (11.5.4.8), ACI 318-14:  $Vs = Vs1 + Vs2 + Vs3 = 1.0556E+006$   
 $Vs1 = 301592.895$  is calculated for pseudo-Column 1, with:  
 $d = 480.00$   
 $Av = 157079.633$   
 $s = 100.00$   
 $fy = 400.00$   
 $Vs1$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $Vs2 = 301592.895$  is calculated for pseudo-Column 2, with:  
 $d = 480.00$   
 $Av = 157079.633$   
 $s = 100.00$   
 $fy = 400.00$   
 $Vs2$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $Vs3 = 452389.342$  is calculated for web, with:  
 $d = 1440.00$   
 $Av = 157079.633$   
 $s = 200.00$   
 $fy = 400.00$   
 $Vs3$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $Vf ((11-3)-(11.4), ACI 440) = 0.00$   
 From (11-11), ACI 440:  $Vs + Vf \leq 1.5943E+006$   
 $bw = 250.00$

-----  
 End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1  
 At local axis: 3  
 -----

Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1  
 At Shear local axis: 2  
 (Bending local axis: 3)  
 Section Type: rcrrws

#### Constant Properties

-----  
 Knowledge Factor,  $= 1.00$   
 Mean strength values are used for both shear and moment calculations.  
 Consequently:  
 Existing material of Primary Member: Concrete Strength,  $fc = fcm = 16.00$   
 Existing material of Primary Member: Steel Strength,  $fs = fsm = 400.00$   
 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  
 Existing material: Steel Strength,  $fs = 1.25*fsm = 500.00$   
 #####  
 Total Height,  $H_{tot} = 3000.00$   
 Edges Width,  $Wedg = 250.00$   
 Edges Height,  $Hedg = 600.00$   
 Web Width,  $Wweb = 250.00$   
 Cover Thickness,  $c = 25.00$   
 Mean Confinement Factor overall section = 1.00  
 Element Length,  $L = 3000.00$   
 Primary Member  
 Ribbed Bars  
 Ductile Steel  
 With Detailing for Earthquake Resistance (including stirrups closed at 135°)  
 Longitudinal Bars With Ends Lapped Starting at the End Sections  
 Adequate Lap Length ( $lo/lo_u, min \geq 1$ )  
 No FRP Wrapping  
 -----

## Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force,  $V_a = -2.0366709E-032$

EDGE -B-

Shear Force,  $V_b = 2.0366709E-032$

BOTH EDGES

Axial Force,  $F = -27514.027$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $As_t = 0.00$

-Compression:  $As_c = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{t,ten} = 2368.761$

-Compression:  $As_{c,com} = 2368.761$

-Middle:  $As_{mid} = 0.00$

(According to 10.7.2.3  $As_{mid}$  is setted equal to zero)

Calculation of Shear Capacity ratio ,  $V_e/V_r = 0.23426757$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n = 211972.373$

with

$M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 3.1796E+008$

$\mu_{u1+} = 2.4327E+008$ , 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

$\mu_{u1-} = 3.1796E+008$ , 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

$M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 3.1796E+008$

$\mu_{u2+} = 2.4327E+008$ , 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

$\mu_{u2-} = 3.1796E+008$ , 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

Calculation of  $\mu_{u1+}$

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

$\phi_u = 0.00019144$

$M_u = 2.4327E+008$

with full section properties:

$b = 3000.00$

$d = 208.00$

$d' = 42.00$

$v = 0.00275581$

$N = 27514.027$

$f_c = 16.00$

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

Final value of  $\phi_{cu}$ :  $\phi_{cu}^* = \text{shear\_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0035$

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

From (5.4b), TBDY:  $\phi_{cu} = 0.0035$

$w_e$  (5.4c) = 0.00

$ase$  ((5.4d), TBDY) =  $(ase1 * A_{col1} + ase2 * A_{col2} + ase3 * A_{web}) / A_{sec} = 0.00$

$ase1 = 0.00$

$sh_1 = 100.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$ase2 = 0.00$

$sh_2 = 100.00$

$bo_2 = 190.00$

$ho\_2 = 540.00$   
 $bi2\_2 = 655400.00$   
ase3 = 0 (grid does not provide confinement)  
 $psh,min = \text{Min}(psh,x, psh,y) = 0.0010472$

$psh,x = ps1,x + ps2,x + ps3,x = 0.00439823$   
 $ps1,x \text{ (column 1)} = (As1 \cdot h1 / s\_1) / Ac = 0.00125664$   
 $h1 = 600.00$   
 $As1 = Astir1 \cdot ns1 = 157.0796$   
No stirups,  $ns1 = 2.00$   
 $ps2,x \text{ (column 2)} = (As2 \cdot h2 / s\_2) / Ac = 0.00125664$   
 $h2 = 600.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
No stirups,  $ns2 = 2.00$   
 $ps3,x \text{ (web)} = (As3 \cdot h3 / s\_3) / Ac = 0.00188496$   
 $h3 = 1800.00$   
 $As3 = Astir3 \cdot ns3 = 0.00$   
No stirups,  $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.0010472$   
 $ps1,y \text{ (column 1)} = (As1 \cdot h1 / s\_1) / Ac = 0.0005236$   
 $h1 = 250.00$   
 $As1 = Astir1 \cdot ns1 = 157.0796$   
No stirups,  $ns1 = 2.00$   
 $ps2,y \text{ (column 2)} = (As2 \cdot h2 / s\_2) / Ac = 0.0005236$   
 $h2 = 250.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
No stirups,  $ns2 = 2.00$   
 $ps3,y \text{ (web)} = (As3 \cdot h3 / s\_3) / Ac = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 \cdot ns3 = 157.0796$   
No stirups,  $ns3 = 0.00$

$Asec = 750000.00$   
 $s\_1 = 100.00$   
 $s\_2 = 100.00$   
 $s\_3 = 200.00$   
 $fywe = 500.00$   
 $fce = 16.00$   
From ((5.A5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $y1 = 0.00208333$   
 $sh1 = 0.00805$   
 $ft1 = 600.00$   
 $fy1 = 500.00$   
 $su1 = 0.03226667$   
using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou,min = lb/l_d = 1.00$   
 $su1 = 0.4 \cdot esu1\_nominal \text{ ((5.5), TBDY)} = 0.03226667$   
From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,  
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, ASCE41-17.  
with  $fs1 = fs = 500.00$   
with  $Es1 = Es = 200000.00$   
 $y2 = 0.00208333$   
 $sh2 = 0.00805$   
 $ft2 = 600.00$   
 $fy2 = 500.00$   
 $su2 = 0.03226667$   
using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou,min = lb/l_b,min = 1.00$   
 $su2 = 0.4 \cdot esu2\_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08066667$ ,  
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  $Min(1, 1.25 \cdot (lb/d)^{2/3})$ , from 10.3.5, ASCE41-17.  
with  $fs2 = fs = 500.00$   
with  $Es2 = Es = 200000.00$   
 $yv = 0.00208333$   
 $shv = 0.00805$   
 $ftv = 600.00$   
 $fyv = 500.00$   
 $suv = 0.03226667$   
using (30) in Biskinis/Fardis (2013) multiplied with  $shear\_factor$   
and also multiplied by the  $shear\_factor$  according to 15.7.1.4, with  
 $Shear\_factor = 1.00$   
 $lo/lou, min = lb/d = 1.00$   
 $suv = 0.4 \cdot esuv\_nominal \cdot ((5.5), TBDY) = 0.03226667$   
From table 5A.1, TBDY:  $esuv\_nominal = 0.08066667$ ,  
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  $Min(1, 1.25 \cdot (lb/d)^{2/3})$ , from 10.3.5, ASCE41-17.  
with  $fsv = fs = 500.00$   
with  $Es v = Es = 200000.00$   
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.11862785$   
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.11862785$   
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00$   
and confined core properties:  
 $b = 2940.00$   
 $d = 178.00$   
 $d' = 12.00$   
 $fcc (5A.2, TBDY) = 16.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.14145031$   
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.14145031$   
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00$   
Case/Assumption: Unconfined full section - Steel rupture  
' does not satisfy Eq. (4.3)  
--->  
 $v < vs, c$  - RHS eq.(4.5) is satisfied  
--->  
 $su (4.9) = 0.18965884$   
 $Mu = MRc (4.14) = 2.4327E+008$   
 $u = su (4.1) = 0.00019144$

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

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

Calculation of  $Mu1$ -  
-----  
-----

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

$u = 0.00019712$   
 $Mu = 3.1796E+008$   
-----

with full section properties:

$b = 3000.00$   
 $d = 208.00$   
 $d' = 42.00$   
 $v = 0.00275581$   
 $N = 27514.027$   
 $fc = 16.00$

$co$  (5A.5, TBDY) = 0.002  
 Final value of  $cu$ :  $cu^* = shear\_factor * Max( cu, cc) = 0.0035$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.0035$   
 $we$  (5.4c) = 0.00  
 $ase$  ((5.4d), TBDY) =  $(ase1 * Acol1 + ase2 * Acol2 + ase3 * Aweb) / Asec = 0.00$   
 $ase1 = 0.00$   
 $sh\_1 = 100.00$   
 $bo\_1 = 190.00$   
 $ho\_1 = 540.00$   
 $bi2\_1 = 655400.00$   
 $ase2 = 0.00$   
 $sh\_2 = 100.00$   
 $bo\_2 = 190.00$   
 $ho\_2 = 540.00$   
 $bi2\_2 = 655400.00$   
 $ase3 = 0$  (grid does not provide confinement)  
 $psh,min = Min(psh,x , psh,y) = 0.0010472$

$psh,x = ps1,x + ps2,x + ps3,x = 0.00439823$   
 $ps1,x$  (column 1) =  $(As1 * h1 / s\_1) / Ac = 0.00125664$   
 $h1 = 600.00$   
 $As1 = Astir1 * ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,x$  (column 2) =  $(As2 * h2 / s\_2) / Ac = 0.00125664$   
 $h2 = 600.00$   
 $As2 = Astir2 * ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,x$  (web) =  $(As3 * h3 / s\_3) / Ac = 0.00188496$   
 $h3 = 1800.00$   
 $As3 = Astir3 * ns3 = 0.00$   
 No stirups,  $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.0010472$   
 $ps1,y$  (column 1) =  $(As1 * h1 / s\_1) / Ac = 0.0005236$   
 $h1 = 250.00$   
 $As1 = Astir1 * ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,y$  (column 2) =  $(As2 * h2 / s\_2) / Ac = 0.0005236$   
 $h2 = 250.00$   
 $As2 = Astir2 * ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,y$  (web) =  $(As3 * h3 / s\_3) / Ac = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 * ns3 = 157.0796$   
 No stirups,  $ns3 = 0.00$

$Asec = 750000.00$   
 $s\_1 = 100.00$   
 $s\_2 = 100.00$   
 $s\_3 = 200.00$   
 $fywe = 500.00$   
 $fce = 16.00$   
 From ((5.A5), TBDY), TBDY:  $cc = 0.002$   
 $c =$  confinement factor = 1.00  
 $y1 = 0.00208333$   
 $sh1 = 0.00805$   
 $ft1 = 600.00$   
 $fy1 = 500.00$   
 $su1 = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $lo/lou,min = lb/d = 1.00$   
 $su1 = 0.4 * esu1\_nominal$  ((5.5), TBDY) = 0.03226667  
 From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,  
 For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered

characteristic value  $f_{sy1} = f_{s1}/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE41-17.  
 with  $f_{s1} = f_s = 500.00$   
 with  $E_{s1} = E_s = 200000.00$   
 $y2 = 0.00208333$   
 $sh2 = 0.00805$   
 $ft2 = 600.00$   
 $fy2 = 500.00$   
 $su2 = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $l_o/l_{o,min} = l_b/l_{b,min} = 1.00$   
 $su2 = 0.4 \cdot esu2_{nominal} ((5.5), TBDY) = 0.03226667$   
 From table 5A.1, TBDY:  $esu2_{nominal} = 0.08066667$ ,  
 For calculation of  $esu2_{nominal}$  and  $y2, sh2, ft2, fy2$ , it is considered  
 characteristic value  $f_{sy2} = f_{s2}/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE41-17.  
 with  $f_{s2} = f_s = 500.00$   
 with  $E_{s2} = E_s = 200000.00$   
 $yv = 0.00208333$   
 $shv = 0.00805$   
 $ftv = 600.00$   
 $fyv = 500.00$   
 $suv = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $l_o/l_{o,min} = l_b/l_d = 1.00$   
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.03226667$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08066667$ ,  
 considering characteristic value  $f_{syv} = f_{sv}/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $yv, shv, ftv, fyv$ , it is considered  
 characteristic value  $f_{syv} = f_{sv}/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE41-17.  
 with  $f_{sv} = f_s = 500.00$   
 with  $E_{sv} = E_s = 200000.00$   
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.11862785$   
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.11862785$   
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.08055366$   
 and confined core properties:  
 $b = 2940.00$   
 $d = 178.00$   
 $d' = 12.00$   
 $f_{cc} (5A.2, TBDY) = 16.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.14145031$   
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.14145031$   
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.09605114$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' does not satisfy Eq. (4.3)  
 --->  
 $v < v_{s,c}$  - RHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.2130262$   
 $Mu = MR_c (4.14) = 3.1796E+008$   
 $u = su (4.1) = 0.00019712$

Calculation of ratio  $l_b/l_d$

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

Calculation of  $Mu2+$

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

$$\phi_u = 0.00019144$$

$$\mu = 2.4327 \times 10^8$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$\nu = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

$$\phi_{0.5} (5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.0035$$

$$\phi_{we} (5.4c) = 0.00$$

$$\phi_{ase} ((5.4d), \text{TBDY}) = (\phi_{ase1} * A_{col1} + \phi_{ase2} * A_{col2} + \phi_{ase3} * A_{web}) / A_{sec} = 0.00$$

$$\phi_{ase1} = 0.00$$

$$s_{h1} = 100.00$$

$$b_{o1} = 190.00$$

$$h_{o1} = 540.00$$

$$b_{i21} = 655400.00$$

$$\phi_{ase2} = 0.00$$

$$s_{h2} = 100.00$$

$$b_{o2} = 190.00$$

$$h_{o2} = 540.00$$

$$b_{i22} = 655400.00$$

$$\phi_{ase3} = 0 \text{ (grid does not provide confinement)}$$

$$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.0010472$$

$$\phi_{psh,x} = \phi_{ps1,x} + \phi_{ps2,x} + \phi_{ps3,x} = 0.00439823$$

$$\phi_{ps1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_{h1}) / A_c = 0.00125664$$

$$h_1 = 600.00$$

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

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

$$\phi_{ps2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_{h2}) / A_c = 0.00125664$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\phi_{ps3,x} \text{ (web)} = (A_{s3} * h_3 / s_{h3}) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirups, } n_{s3} = 2.00$$

$$\phi_{psh,y} = \phi_{ps1,y} + \phi_{ps2,y} + \phi_{ps3,y} = 0.0010472$$

$$\phi_{ps1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_{h1}) / A_c = 0.0005236$$

$$h_1 = 250.00$$

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

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

$$\phi_{ps2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_{h2}) / A_c = 0.0005236$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\phi_{ps3,y} \text{ (web)} = (A_{s3} * h_3 / s_{h3}) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

$$\text{No stirups, } n_{s3} = 0.00$$

$$A_{sec} = 750000.00$$

$$s_{h1} = 100.00$$

$$s_{h2} = 100.00$$

$$s_{h3} = 200.00$$

$$f_{ywe} = 500.00$$

$$f_{ce} = 16.00$$

```

From ((5.A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00208333
sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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, ASCE41-17.
with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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, ASCE41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785
2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031
2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->

```



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

---->

$$s_u(4.9) = 0.18965884$$

$$\mu_u = M_{Rc}(4.14) = 2.4327E+008$$

$$u = s_u(4.1) = 0.00019144$$

Calculation of ratio  $I_b/I_d$

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

Calculation of  $\mu_u$ -

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

$$u = 0.00019712$$

$$\mu_u = 3.1796E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear\_factor} * \text{Max}(c_u, c_c) = 0.0035$$

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

$$\text{From (5.4b), TB DY: } c_u = 0.0035$$

$$w_e(5.4c) = 0.00$$

$$a_{se}((5.4d), \text{TB DY}) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh\_1 = 100.00$$

$$bo\_1 = 190.00$$

$$ho\_1 = 540.00$$

$$bi2\_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh\_2 = 100.00$$

$$bo\_2 = 190.00$$

$$ho\_2 = 540.00$$

$$bi2\_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.0010472$$

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00439823$$

$$p_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_{_1}) / A_c = 0.00125664$$

$$h_1 = 600.00$$

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

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

$$p_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_{_2}) / A_c = 0.00125664$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$p_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_{_3}) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirups, } n_{s3} = 2.00$$

$$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.0010472$$

$$p_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_{_1}) / A_c = 0.0005236$$

$$h_1 = 250.00$$

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

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

$$p_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_{_2}) / A_c = 0.0005236$$

$h2 = 250.00$   
 $As2 = Astir2 * ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,y (web) = (As3 * h3 / s_3) / Ac = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 * ns3 = 157.0796$   
 No stirups,  $ns3 = 0.00$

-----

$Asec = 750000.00$

$s_1 = 100.00$

$s_2 = 100.00$

$s_3 = 200.00$

$fywe = 500.00$

$fce = 16.00$

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

$c =$  confinement factor  $= 1.00$

$y1 = 0.00208333$

$sh1 = 0.00805$

$ft1 = 600.00$

$fy1 = 500.00$

$su1 = 0.03226667$

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

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

$su1 = 0.4 * esu1\_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fs1 = fs = 500.00$

with  $Es1 = Es = 200000.00$

$y2 = 0.00208333$

$sh2 = 0.00805$

$ft2 = 600.00$

$fy2 = 500.00$

$su2 = 0.03226667$

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

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

$su2 = 0.4 * esu2\_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08066667$ ,

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  $Min(1, 1.25 * (lb/ld)^{2/3})$ , from 10.3.5, ASCE41-17.

with  $fs2 = fs = 500.00$

with  $Es2 = Es = 200000.00$

$yv = 0.00208333$

$shv = 0.00805$

$ftv = 600.00$

$fyv = 500.00$

$suv = 0.03226667$

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

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

$suv = 0.4 * esuv\_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY:  $esuv\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fsv = fs = 500.00$

with  $Esv = Es = 200000.00$

$1 = Asl,ten / (b * d) * (fs1 / fc) = 0.11862785$

$2 = Asl,com / (b * d) * (fs2 / fc) = 0.11862785$

$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.08055366$   
 and confined core properties:  
 $b = 2940.00$   
 $d = 178.00$   
 $d' = 12.00$   
 $f_{cc} (5A.2, TBDY) = 16.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.14145031$   
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.14145031$   
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.09605114$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' does not satisfy Eq. (4.3)  
 --->  
 $v < v_{s,c}$  - RHS eq.(4.5) is satisfied  
 --->  
 $\mu (4.9) = 0.2130262$   
 $M_u = M_{Rc} (4.14) = 3.1796E+008$   
 $u = \mu (4.1) = 0.00019712$

Calculation of ratio  $l_b/d$

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

Calculation of Shear Strength  $V_r = \min(V_{r1}, V_{r2}) = 904830.218$

Calculation of Shear Strength at edge 1,  $V_{r1} = 904830.218$   
 From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r1} = V_n < 0.83*f'_c*0.5*h*d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$   
 $M_u/V_u - l_w/2 = 0.00 \leq 0$   
 $= 1$  (normal-weight concrete)  
 $f'_c = 16.00$ , but  $f'_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $h = 3000.00$   
 $d = 200.00$   
 $l_w = 250.00$   
 $M_u = 2.0446822E-012$   
 $V_u = 2.0366709E-032$   
 $N_u = 27514.027$   
 From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 251327.412$   
 $V_{s1} = 125663.706$  is calculated for pseudo-Column 1, with:  
 $d = 200.00$   
 $A_v = 157079.633$   
 $s = 100.00$   
 $f_y = 400.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 125663.706$  is calculated for pseudo-Column 2, with:  
 $d = 200.00$   
 $A_v = 157079.633$   
 $s = 100.00$   
 $f_y = 400.00$   
 $V_{s2}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s3} = 0.00$  is calculated for web, with:  
 $d = 200.00$   
 $A_v = 0.00$   
 $s = 200.00$   
 $f_y = 400.00$   
 $V_{s3}$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)  
 $2(1-s/d) = 0.00$   
 $V_f ((11-3)-(11.4), ACI 440) = 0.00$

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$   
 $bw = 3000.00$

Calculation of Shear Strength at edge 2,  $V_{r2} = 904830.218$   
From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r2} = V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$   
 $\mu_u / \mu_u - l_w / 2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$ , but  $f_c'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$\mu_u = 2.0446822E-012$

$V_u = 2.0366709E-032$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 251327.412$

$V_{s1} = 125663.706$  is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s2} = 125663.706$  is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s3} = 0.00$  is calculated for web, with:

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 400.00$

$V_{s3}$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17, 10.3.4)

$2(1-s/d) = 0.00$

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

$bw = 3000.00$

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1  
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1  
At local axis: 3  
Integration Section: (a)  
Section Type: rcrrws

Constant Properties

Knowledge Factor, = 1.00

According to 10.7.2.3, ASCE 41-17, shear walls with  
transverse reinforcement percentage,  $n < 0.0015$

are considered Force-Controlled and lower-bound strengths are used according to 7.5.1.3, ASCE 41-17  
 $n = 0.0010472$

with  $n = \rho_{s1} + \rho_{s2} + \rho_{s3}$ , being the shear reinf. ratio in a plane perpendicular to the shear axis 2  
(pseudo-col.1  $\rho_{s1} = A_{s1} \cdot b_1 / s_1 = (A_{s1} \cdot h_1 / s_1) / A_c = 0.0005236$

$h_1 = 250.00$

$s_1 = 100.00$

total area of hoops perpendicular to shear axis,  $A_{s1} = 157.0796$

(pseudo-col.2 ps2 =  $As2 \cdot b2 / s2 = (As2 \cdot h2 / s2) / Ac = 0.0005236$   
 $h2 = 250.00$   
 $s2 = 100.00$   
total area of hoops perpendicular to shear axis,  $As2 = 157.0796$   
(grid ps3 =  $As3 \cdot b3 / s3 = (As3 \cdot h3 / s3) / Ac = 0.00$   
 $h3 = 250.00$   
 $s3 = 200.00$   
total area of hoops perpendicular to shear axis,  $As3 = 0.00$   
total section area,  $Ac = 750000.00$

Consequently:

Existing material of Primary Member: Concrete Strength,  $fc = fc\_lower\_bound = 16.00$   
Existing material of Primary Member: Steel Strength,  $fs = fs\_lower\_bound = 400.00$   
Concrete Elasticity,  $Ec = 21019.039$   
Steel Elasticity,  $Es = 200000.00$   
Total Height,  $H_{tot} = 3000.00$   
Edges Width,  $W_{edg} = 250.00$   
Edges Height,  $H_{edg} = 600.00$   
Web Width,  $W_{web} = 250.00$   
Cover Thickness,  $c = 25.00$   
Element Length,  $L = 3000.00$   
Primary Member  
Ribbed Bars  
Ductile Steel  
With Detailing for Earthquake Resistance (including stirrups closed at 135°)  
Longitudinal Bars With Ends Lapped Starting at the End Sections  
Adequate Lap Length ( $l_b / l_d > 1$ )  
No FRP Wrapping

Stepwise Properties

Bending Moment,  $M = -1.3025053E-010$   
Shear Force,  $V2 = -6.3979846E-014$   
Shear Force,  $V3 = -25423.336$   
Axial Force,  $F = -27598.912$   
Longitudinal Reinforcement Area Distribution (in 2 divisions)  
-Tension:  $As_{lt} = 0.00$   
-Compression:  $As_{lc} = 6346.017$   
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $As_{l,ten} = 2368.761$   
-Compression:  $As_{l,com} = 2368.761$   
-Middle:  $As_{l,mid} = 1608.495$   
Mean Diameter of Tension Reinforcement,  $DbL = 17.20$

Existing component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u_R = u = 0.00385818$   
 $u = y + p = 0.00385818$

- Calculation of  $y$  -

$y = (M_y \cdot I_p) / (EI)_{Eff} = 0.00185818$  ((10-5), ASCE 41-17))  
 $M_y = 2.2249E+008$   
 $(EI)_{Eff} = 0.35 \cdot Ec \cdot I$  (table 10-5)  
 $Ec \cdot I = 8.2106E+013$   
 $I_p = 0.5 \cdot d = 0.5 \cdot (0.8 \cdot h) = 240.00$

Calculation of Yielding Moment  $M_y$

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

$y = \text{Min}(y_{ten}, y_{com})$

```

y_ten = 1.2992433E-005
with fy = 400.00
  d = 208.00
  y = 0.25992422
  A = 0.01028047
  B = 0.00622229
  with pt = 0.00379609
    pc = 0.00379609
    pv = 0.00257772
    N = 27598.912
    b = 3000.00
    " = 0.20192308
y_comp = 2.5448441E-005
with fc = 16.00
  Ec = 21019.039
  y = 0.25885414
  A = 0.0100085
  B = 0.00611172
  with Es = 200000.00

```

Calculation of ratio  $I_b/I_d$

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

- Calculation of  $p$  -

Considering wall controlled by flexure (shear control ratio  $\leq 1$ ),  
from table 10-19:  $p = 0.002$

with:

- Condition i (shear wall and wall segments)

-  $(A_s - A_s') \cdot f_y + P / (t_w \cdot l_w \cdot f_c') = -0.209234$

$A_s = 0.00$

$A_s' = 6346.017$

$f_y = 400.00$

$P = 27598.912$

$t_w = 3000.00$

$l_w = 250.00$

$f_c = 16.00$

-  $V / (t_w \cdot l_w \cdot f_c^{0.5}) = 2.5682965E-019$ , NOTE: units in lb & in

- Confined Boundary: No

Boundary hoops spacing does not exceed  $8d_b$  ( $s_1 < 8 \cdot d_b$  and  $s_2 < 8 \cdot d_b$ )

Boundary Trans. Reinf. does not exceed 50% of ACI 318 provision ( $V_{w1} + V_{w2} > 0.50 \cdot (V - V_c - V_{w3})$ )

With

Boundary Element 1:

$V_{w1} = 125663.706$

$s_1 = 100.00$

Boundary Element 2:

$V_{w2} = 125663.706$

$s_2 = 100.00$

Grid Shear Force,  $V_{w3} = 0.00$

Concrete Shear Force,  $V_c = 151978.111$

(The variables above have already been given in Shear control ratio calculation)

Mean diameter of all bars,  $d_b = 17.33333$

Design Shear Force,  $V = 6.3979846E-014$

End Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (a)

## Calculation No. 5

wall W1, Floor 1

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

Analysis: Uniform +X

Check: Shear capacity  $VR_d$

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcwls

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.

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

Consequently:

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,  $E_s = 200000.00$

Total Height,  $H_{tot} = 3000.00$

Edges Width,  $W_{edg} = 250.00$

Edges Height,  $H_{edg} = 600.00$

Web Width,  $W_{web} = 250.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

EDGE -A-  
 Bending Moment,  $M_a = -1.3025053E-010$   
 Shear Force,  $V_a = -6.3979846E-014$   
 EDGE -B-  
 Bending Moment,  $M_b = -6.2019971E-011$   
 Shear Force,  $V_b = 6.3979846E-014$   
 BOTH EDGES  
 Axial Force,  $F = -27598.912$   
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
   -Tension:  $A_{st} = 0.00$   
   -Compression:  $A_{sc} = 6346.017$   
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $A_{st,ten} = 2368.761$   
   -Compression:  $A_{sc,com} = 2368.761$   
   -Middle:  $A_{st,mid} = 1608.495$   
 Mean Diameter of Tension Reinforcement,  $Db_{L,ten} = 17.20$

Existing component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $V_R = V_n = 443693.972$   
 From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d = 443693.972$

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

From Table (11.5.4.6(d-e)), ACI 318-14:  $V_c = 192366.559$   
 $M_u/V_u - l_w/2 = 844.3673 > 0$   
   = 1 (normal-weight concrete)  
 $f_c' = 16.00$ , but  $f_c'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $h = 3000.00$   
 $d = 200.00$   
 $l_w = 250.00$   
 $M_u = 6.2019971E-011$   
 $V_u = 6.3979846E-014$   
 $N_u = 27598.912$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 251327.412$

$V_{s1} = 125663.706$  is calculated for pseudo-Column 1, with:

$d = 200.00$   
 $A_v = 157079.633$   
 $s = 100.00$   
 $f_y = 400.00$

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

$V_{s2} = 125663.706$  is calculated for pseudo-Column 2, with:

$d = 200.00$   
 $A_v = 157079.633$   
 $s = 100.00$   
 $f_y = 400.00$

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

$V_{s3} = 0.00$  is calculated for web, with:

$d = 200.00$   
 $A_v = 0.00$   
 $s = 200.00$   
 $f_y = 400.00$

$V_{s3}$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

$b_w = 3000.00$

End Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (b)



## Calculation No. 6

wall W1, Floor 1

Limit State: Operational Level (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: wall W1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcwrs

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

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

Consequently:

Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 16.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 400.00$

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

Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 500.00$

#####

Total Height,  $H_{tot} = 3000.00$

Edges Width,  $W_{edg} = 250.00$

Edges Height,  $H_{edg} = 600.00$

Web Width,  $W_{web} = 250.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

#### Stepwise Properties

At local axis: 3  
EDGE -A-  
Shear Force,  $V_a = -3.6423187E-030$   
EDGE -B-  
Shear Force,  $V_b = 3.6423187E-030$   
BOTH EDGES  
Axial Force,  $F = -27514.027$   
Longitudinal Reinforcement Area Distribution (in 2 divisions)  
-Tension:  $As_t = 0.00$   
-Compression:  $As_c = 6346.017$   
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $As_{t,ten} = 2865.133$   
-Compression:  $As_{c,com} = 2865.133$   
-Middle:  $As_{mid} = 0.00$   
(According to 10.7.2.3  $As_{mid}$  is setted equal to zero)

Calculation of Shear Capacity ratio,  $V_e/V_r = 2.25608$   
Member Controlled by Shear ( $V_e/V_r > 1$ )  
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n = 3.8558E+006$   
with  
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 5.7837E+009$   
 $\mu_{u1+} = 5.0210E+009$ , 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  
 $\mu_{u1-} = 5.7837E+009$ , 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  
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 5.7837E+009$   
 $\mu_{u2+} = 5.0210E+009$ , 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  
 $\mu_{u2-} = 5.7837E+009$ , 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

#### Calculation of $\mu_{u1+}$

Calculation of ultimate curvature  $\mu_u$  according to 4.1, Biskinis/Fardis 2013:  
 $\mu_u = 1.1673539E-005$   
 $\mu_u = 5.0210E+009$

with full section properties:

$b = 250.00$   
 $d = 2957.00$   
 $d' = 43.00$   
 $v = 0.00232618$   
 $N = 27514.027$   
 $f_c = 16.00$   
 $\phi_c (5A.5, \text{TBDY}) = 0.002$   
Final value of  $\phi_{cu}$ :  $\phi_{cu} = \text{shear\_factor} * \max(\phi_{cu}, \phi_c) = 0.0035$   
The Shear\_factor is considered equal to 1 (pure moment strength)  
From (5.4b), TBDY:  $\phi_{cu} = 0.0035$   
 $\phi_{we} (5.4c) = 0.00$   
 $\phi_{ase} ((5.4d), \text{TBDY}) = (\phi_{ase1} * A_{col1} + \phi_{ase2} * A_{col2} + \phi_{ase3} * A_{web}) / A_{sec} = 0.00$   
 $\phi_{ase1} = 0.00$   
 $\phi_{sh\_1} = 100.00$   
 $\phi_{bo\_1} = 190.00$   
 $\phi_{ho\_1} = 540.00$   
 $\phi_{bi2\_1} = 655400.00$

```

ase2 = 0.00
sh_2 = 100.00
bo_2 = 190.00
ho_2 = 540.00
bi2_2 = 655400.00
ase3 = 0 (grid does not provide confinement)
psh,min = Min(psh,x , psh,y) = 0.0010472

```

```

-----
psh,x = ps1,x+ps2,x+ps3,x = 0.00439823
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00125664
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00125664
h2 = 600.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,x (web) = (As3*h3/s_3)/Ac = 0.00188496
h3 = 1800.00
As3 = Astir3*ns3 = 0.00
No stirups, ns3 = 2.00

```

```

-----
psh,y = ps1,y+ps2,y+ps3,y = 0.0010472
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.0005236
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.0005236
h2 = 250.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
h3 = 250.00
As3 = Astir3*ns3 = 157.0796
No stirups, ns3 = 0.00

```

```

-----
Asec = 750000.00
s_1 = 100.00
s_2 = 100.00
s_3 = 200.00
fywe = 500.00
fce = 16.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00208333
sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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, ASCE41-17.
with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

```

```

Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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, ASCE41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652
2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723
2 = Asl,com/(b*d)*(fs2/fc) = 0.16099723
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.06523978
Mu = MRc (4.14) = 5.0210E+009
u = su (4.1) = 1.1673539E-005

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

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

u = 1.1958028E-005

Mu = 5.7837E+009

with full section properties:

b = 250.00

d = 2957.00

d' = 43.00

$v = 0.00232618$   
 $N = 27514.027$   
 $f_c = 16.00$   
 $\phi_c (5A.5, TBDY) = 0.002$   
 Final value of  $\phi_c$ :  $\phi_c = \text{shear\_factor} * \text{Max}(\phi_c, \phi_c) = 0.0035$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $\phi_c = 0.0035$   
 $\phi_w (5.4c) = 0.00$   
 $\phi_{se} ((5.4d), TBDY) = (\phi_{se1} * A_{col1} + \phi_{se2} * A_{col2} + \phi_{se3} * A_{web}) / A_{sec} = 0.00$   
 $\phi_{se1} = 0.00$   
 $sh_1 = 100.00$   
 $bo_1 = 190.00$   
 $ho_1 = 540.00$   
 $bi2_1 = 655400.00$   
 $\phi_{se2} = 0.00$   
 $sh_2 = 100.00$   
 $bo_2 = 190.00$   
 $ho_2 = 540.00$   
 $bi2_2 = 655400.00$   
 $\phi_{se3} = 0$  (grid does not provide confinement)  
 $\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.0010472$

$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00439823$   
 $\phi_{s1,x} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00125664$   
 $h_1 = 600.00$   
 $A_{s1} = A_{stir1} * n_{s1} = 157.0796$   
 No stirups,  $n_{s1} = 2.00$   
 $\phi_{s2,x} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00125664$   
 $h_2 = 600.00$   
 $A_{s2} = A_{stir2} * n_{s2} = 157.0796$   
 No stirups,  $n_{s2} = 2.00$   
 $\phi_{s3,x} (\text{web}) = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$   
 $h_3 = 1800.00$   
 $A_{s3} = A_{stir3} * n_{s3} = 0.00$   
 No stirups,  $n_{s3} = 2.00$

$\phi_{sh,y} = \phi_{s1,y} + \phi_{s2,y} + \phi_{s3,y} = 0.0010472$   
 $\phi_{s1,y} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.0005236$   
 $h_1 = 250.00$   
 $A_{s1} = A_{stir1} * n_{s1} = 157.0796$   
 No stirups,  $n_{s1} = 2.00$   
 $\phi_{s2,y} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.0005236$   
 $h_2 = 250.00$   
 $A_{s2} = A_{stir2} * n_{s2} = 157.0796$   
 No stirups,  $n_{s2} = 2.00$   
 $\phi_{s3,y} (\text{web}) = (A_{s3} * h_3 / s_3) / A_c = 0.00$   
 $h_3 = 250.00$   
 $A_{s3} = A_{stir3} * n_{s3} = 157.0796$   
 No stirups,  $n_{s3} = 0.00$

$A_{sec} = 750000.00$   
 $s_1 = 100.00$   
 $s_2 = 100.00$   
 $s_3 = 200.00$

$f_{ywe} = 500.00$   
 $f_{ce} = 16.00$

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

$y_1 = 0.00208333$   
 $sh_1 = 0.00805$

$f_{t1} = 600.00$   
 $f_{y1} = 500.00$

$su_1 = 0.03226667$

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

```

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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, ASCE41-17.
with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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, ASCE41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652
2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652
v = Asl,mid/(b*d)*(fsv/fc) = 0.02602943
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723
2 = Asl,com/(b*d)*(fs2/fc) = 0.16099723
v = Asl,mid/(b*d)*(fsv/fc) = 0.03460028
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.8) = 0.08747825
Mu = MRc (4.15) = 5.7837E+009
u = su (4.1) = 1.1958028E-005

```

Calculation of ratio lb/ld

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

Calculation of  $\mu_{2+}$

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

$$\mu = 1.1673539E-005$$

$$\mu_u = 5.0210E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \mu_u: \mu_u^* = \text{shear\_factor} * \text{Max}(\mu_u, c_o) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \mu_u = 0.0035$$

$$w_e \text{ (5.4c)} = 0.00$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 100.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 100.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.0010472$$

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00439823$$

$$p_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00125664$$

$$h_1 = 600.00$$

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

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

$$p_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00125664$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$p_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirups, } n_{s3} = 2.00$$

$$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.0010472$$

$$p_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.0005236$$

$$h_1 = 250.00$$

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

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

$$p_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.0005236$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$p_{s3,y} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

$$\text{No stirups, } n_{s3} = 0.00$$

$$A_{sec} = 750000.00$$

```

s_1 = 100.00
s_2 = 100.00
s_3 = 200.00
fywe = 500.00
fce = 16.00
From ((5A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00208333
sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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, ASCE41-17.
with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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, ASCE41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652
2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723

```



$$2 = A_{sl,com}/(b*d)*(f_s2/f_c) = 0.16099723$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.00$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

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

---->

$$s_u(4.9) = 0.06523978$$

$$\mu_u = M_{Rc}(4.14) = 5.0210E+009$$

$$u = s_u(4.1) = 1.1673539E-005$$

Calculation of ratio  $I_b/I_d$

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

Calculation of  $\mu_{u2}$ -

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

$$u = 1.1958028E-005$$

$$\mu_u = 5.7837E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \mu_{cu}: \mu_{cu}^* = \text{shear\_factor} * \text{Max}(\mu_{cu}, \mu_{cc}) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \mu_{cu} = 0.0035$$

$$\mu_{we}(5.4c) = 0.00$$

$$\mu_{ase}((5.4d), TBDY) = (\mu_{ase1} * A_{col1} + \mu_{ase2} * A_{col2} + \mu_{ase3} * A_{web}) / A_{sec} = 0.00$$

$$\mu_{ase1} = 0.00$$

$$sh_1 = 100.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$\mu_{ase2} = 0.00$$

$$sh_2 = 100.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$\mu_{ase3} = 0 \text{ (grid does not provide confinement)}$$

$$\mu_{psh,min} = \text{Min}(\mu_{psh,x}, \mu_{psh,y}) = 0.0010472$$

$$\mu_{psh,x} = \mu_{ps1,x} + \mu_{ps2,x} + \mu_{ps3,x} = 0.00439823$$

$$\mu_{ps1,x}(\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00125664$$

$$h_1 = 600.00$$

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

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

$$\mu_{ps2,x}(\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00125664$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\mu_{ps3,x}(\text{web}) = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirups, } n_{s3} = 2.00$$

$$\mu_{psh,y} = \mu_{ps1,y} + \mu_{ps2,y} + \mu_{ps3,y} = 0.0010472$$

ps1,y (column 1) =  $(As1 \cdot h1 / s_1) / Ac = 0.0005236$

h1 = 250.00

As1 = Astir1\*ns1 = 157.0796

No stirups, ns1 = 2.00

ps2,y (column 2) =  $(As2 \cdot h2 / s_2) / Ac = 0.0005236$

h2 = 250.00

As2 = Astir2\*ns2 = 157.0796

No stirups, ns2 = 2.00

ps3,y (web) =  $(As3 \cdot h3 / s_3) / Ac = 0.00$

h3 = 250.00

As3 = Astir3\*ns3 = 157.0796

No stirups, ns3 = 0.00

Asec = 750000.00

s\_1 = 100.00

s\_2 = 100.00

s\_3 = 200.00

fywe = 500.00

fce = 16.00

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

c = confinement factor = 1.00

y1 = 0.00208333

sh1 = 0.00805

ft1 = 600.00

fy1 = 500.00

su1 = 0.03226667

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

lo/lou,min = lb/lb = 1.00

su1 =  $0.4 \cdot esu1\_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY: esu1\_nominal = 0.08066667,

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, ASCE41-17.

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

y2 = 0.00208333

sh2 = 0.00805

ft2 = 600.00

fy2 = 500.00

su2 = 0.03226667

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

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

su2 =  $0.4 \cdot esu2\_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY: esu2\_nominal = 0.08066667,

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, ASCE41-17.

with fs2 = fs = 500.00

with Es2 = Es = 200000.00

yv = 0.00208333

shv = 0.00805

ftv = 600.00

fyv = 500.00

suv = 0.03226667

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

lo/lou,min = lb/lb = 1.00

suv =  $0.4 \cdot esuv\_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY: esuv\_nominal = 0.08066667,

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

$y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$ , from 10.3.5, ASCE41-17.  
 with  $fsv = fs = 500.00$   
 with  $Esv = Es = 200000.00$   
 $1 = Asl,ten/(b \cdot d) \cdot (fs1/fc) = 0.12111652$   
 $2 = Asl,com/(b \cdot d) \cdot (fs2/fc) = 0.12111652$   
 $v = Asl,mid/(b \cdot d) \cdot (fsv/fc) = 0.02602943$

and confined core properties:

$b = 190.00$   
 $d = 2927.00$   
 $d' = 13.00$   
 $fcc (5A.2, TBDY) = 16.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl,ten/(b \cdot d) \cdot (fs1/fc) = 0.16099723$   
 $2 = Asl,com/(b \cdot d) \cdot (fs2/fc) = 0.16099723$   
 $v = Asl,mid/(b \cdot d) \cdot (fsv/fc) = 0.03460028$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

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

--->

$su (4.8) = 0.08747825$   
 $Mu = MRc (4.15) = 5.7837E+009$   
 $u = su (4.1) = 1.1958028E-005$

Calculation of ratio  $lb/d$

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

Calculation of Shear Strength  $Vr = \text{Min}(Vr1, Vr2) = 1.7091E+006$

Calculation of Shear Strength at edge 1,  $Vr1 = 1.7091E+006$   
 From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $Vr1 = Vn < 0.83 \cdot fc' \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14:  $Vc = 653502.805$   
 $Mu/Vu \cdot lw/2 = 0.00 \leq 0$   
 $= 1$  (normal-weight concrete)  
 $fc' = 16.00$ , but  $fc'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $h = 250.00$   
 $d = 2400.00$   
 $lw = 3000.00$   
 $Mu = 2.8146476E-010$   
 $Vu = 3.6423187E-030$   
 $Nu = 27514.027$   
 From (11.5.4.8), ACI 318-14:  $Vs = Vs1 + Vs2 + Vs3 = 1.0556E+006$   
 $Vs1 = 301592.895$  is calculated for pseudo-Column 1, with:  
 $d = 480.00$   
 $Av = 157079.633$   
 $s = 100.00$   
 $fy = 400.00$   
 $Vs1$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17, 10.3.4)  
 $Vs2 = 301592.895$  is calculated for pseudo-Column 2, with:  
 $d = 480.00$   
 $Av = 157079.633$   
 $s = 100.00$   
 $fy = 400.00$   
 $Vs2$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17, 10.3.4)  
 $Vs3 = 452389.342$  is calculated for web, with:

d = 1440.00

Av = 157079.633

s = 200.00

fy = 400.00

Vs3 has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

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

From (11-11), ACI 440: Vs + Vf <= 1.5943E+006

bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 1.7091E+006

From (22.5.1.1) and 11.5.4.3, ACI 318-14: Vr2 = Vn <  $0.83 \cdot f_c' \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14: Vc = 653502.805

Mu/Vu-lw/2 = 0.00 <= 0

= 1 (normal-weight concrete)

fc' = 16.00, but  $fc'^{0.5} <= 8.3$  MPa (22.5.3.1, ACI 318-14)

h = 250.00

d = 2400.00

lw = 3000.00

Mu = 2.8146476E-010

Vu = 3.6423187E-030

Nu = 27514.027

From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 + Vs3 = 1.0556E+006

Vs1 = 301592.895 is calculated for pseudo-Column 1, with:

d = 480.00

Av = 157079.633

s = 100.00

fy = 400.00

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

Vs2 = 301592.895 is calculated for pseudo-Column 2, with:

d = 480.00

Av = 157079.633

s = 100.00

fy = 400.00

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

Vs3 = 452389.342 is calculated for web, with:

d = 1440.00

Av = 157079.633

s = 200.00

fy = 400.00

Vs3 has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

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

From (11-11), ACI 440: Vs + Vf <= 1.5943E+006

bw = 250.00

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1  
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1  
At Shear local axis: 2  
(Bending local axis: 3)  
Section Type: rcrws

Constant Properties

Knowledge Factor, = 1.00

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

Consequently:

Existing material of Primary Member: Concrete Strength, fc = fcm = 16.00

Existing material of Primary Member: Steel Strength, fs = fsm = 400.00

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
Existing material: Steel Strength, fs = 1.25*fsm = 500.00
#####
Total Height, Htot = 3000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 600.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping
-----

Stepwise Properties
-----
At local axis: 2
EDGE -A-
Shear Force, Va = -2.0366709E-032
EDGE -B-
Shear Force, Vb = 2.0366709E-032
BOTH EDGES
Axial Force, F = -27514.027
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 6346.017
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 2368.761
-Compression: Asl,com = 2368.761
-Middle: Asl,mid = 0.00
(According to 10.7.2.3 Asl,mid is setted equal to zero)
-----
-----

Calculation of Shear Capacity ratio , Ve/Vr = 0.23426757
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 211972.373
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.1796E+008
Mu1+ = 2.4327E+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- = 3.1796E+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-) = 3.1796E+008
Mu2+ = 2.4327E+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- = 3.1796E+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
-----

Calculation of Mu1+
-----

-----

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 0.00019144
Mu = 2.4327E+008
-----

```

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi: \phi^* = \text{shear\_factor} * \text{Max}(\phi, \phi_c) = 0.0035$$

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

$$\text{From (5.4b), TB DY: } \phi = 0.0035$$

$$\phi_e (5.4c) = 0.00$$

$$\phi_{se} ((5.4d), \text{TB DY}) = (\phi_{se1} * A_{col1} + \phi_{se2} * A_{col2} + \phi_{se3} * A_{web}) / A_{sec} = 0.00$$

$$\phi_{se1} = 0.00$$

$$s_{h1} = 100.00$$

$$b_{o1} = 190.00$$

$$h_{o1} = 540.00$$

$$b_{i2,1} = 655400.00$$

$$\phi_{se2} = 0.00$$

$$s_{h2} = 100.00$$

$$b_{o2} = 190.00$$

$$h_{o2} = 540.00$$

$$b_{i2,2} = 655400.00$$

$$\phi_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.0010472$$

$$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00439823$$

$$\phi_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_{h1}) / A_c = 0.00125664$$

$$h_1 = 600.00$$

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

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

$$\phi_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_{h2}) / A_c = 0.00125664$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\phi_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_{h3}) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirups, } n_{s3} = 2.00$$

$$\phi_{sh,y} = \phi_{s1,y} + \phi_{s2,y} + \phi_{s3,y} = 0.0010472$$

$$\phi_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_{h1}) / A_c = 0.0005236$$

$$h_1 = 250.00$$

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

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

$$\phi_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_{h2}) / A_c = 0.0005236$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\phi_{s3,y} \text{ (web)} = (A_{s3} * h_3 / s_{h3}) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

$$\text{No stirups, } n_{s3} = 0.00$$

$$A_{sec} = 750000.00$$

$$s_{h1} = 100.00$$

$$s_{h2} = 100.00$$

$$s_{h3} = 200.00$$

$$f_{ywe} = 500.00$$

$$f_{ce} = 16.00$$

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

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

$$y_1 = 0.00208333$$

$$s_{h1} = 0.00805$$

$$f_{t1} = 600.00$$

$$f_{y1} = 500.00$$

$$s_{u1} = 0.03226667$$

```

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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, ASCE41-17.
with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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, ASCE41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785
2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031
2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18965884
Mu = MRc (4.14) = 2.4327E+008
u = su (4.1) = 0.00019144

```

Calculation of ratio  $l_b/l_d$

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

Calculation of  $\mu_1$ -

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

$$\mu = 0.00019712$$

$$\mu_u = 3.1796 \times 10^8$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \mu_u: \mu_u^* = \text{shear\_factor} * \text{Max}(\mu_u, c_o) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \mu_u = 0.0035$$

$$\mu_{se} \text{ (5.4c)} = 0.00$$

$$\mu_{se} \text{ ((5.4d), TBDY)} = (\mu_{se1} * A_{col1} + \mu_{se2} * A_{col2} + \mu_{se3} * A_{web}) / A_{sec} = 0.00$$

$$\mu_{se1} = 0.00$$

$$sh_1 = 100.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$\mu_{se2} = 0.00$$

$$sh_2 = 100.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$\mu_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$\mu_{sh,min} = \text{Min}(\mu_{sh,x}, \mu_{sh,y}) = 0.0010472$$

$$\mu_{sh,x} = \mu_{s1,x} + \mu_{s2,x} + \mu_{s3,x} = 0.00439823$$

$$\mu_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00125664$$

$$h_1 = 600.00$$

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

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

$$\mu_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00125664$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\mu_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirups, } n_{s3} = 2.00$$

$$\mu_{sh,y} = \mu_{s1,y} + \mu_{s2,y} + \mu_{s3,y} = 0.0010472$$

$$\mu_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.0005236$$

$$h_1 = 250.00$$

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

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

$$\mu_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.0005236$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\mu_{s3,y} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

$$\text{No stirups, } n_{s3} = 0.00$$



```

Asec = 750000.00
s_1 = 100.00
s_2 = 100.00
s_3 = 200.00
fywe = 500.00
fce = 16.00
From ((5.A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00208333
sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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, ASCE41-17.
with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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, ASCE41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785
2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785
v = Asl,mid/(b*d)*(fsv/fc) = 0.08055366
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002

```

$c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.14145031$   
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.14145031$   
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.09605114$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' does not satisfy Eq. (4.3)

--->  
 $v < v_{s,c}$  - RHS eq.(4.5) is satisfied  
 --->  
 $s_u(4.9) = 0.2130262$   
 $M_u = M_{Rc}(4.14) = 3.1796E+008$   
 $u = s_u(4.1) = 0.00019712$

Calculation of ratio  $l_b/l_d$

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

Calculation of  $M_{u2+}$

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

$u = 0.00019144$   
 $M_u = 2.4327E+008$

with full section properties:

$b = 3000.00$   
 $d = 208.00$   
 $d' = 42.00$   
 $v = 0.00275581$   
 $N = 27514.027$   
 $f_c = 16.00$   
 $\alpha(5A.5, TBDY) = 0.002$   
 Final value of  $\alpha$ :  $\alpha = \text{shear\_factor} * \text{Max}(\alpha_c, \alpha_s) = 0.0035$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $\alpha = 0.0035$   
 $\alpha_w(5.4c) = 0.00$   
 $\alpha_{se}((5.4d), TBDY) = (\alpha_{se1}*A_{col1} + \alpha_{se2}*A_{col2} + \alpha_{se3}*A_{web})/A_{sec} = 0.00$   
 $\alpha_{se1} = 0.00$   
 $sh_1 = 100.00$   
 $bo_1 = 190.00$   
 $ho_1 = 540.00$   
 $bi2_1 = 655400.00$   
 $\alpha_{se2} = 0.00$   
 $sh_2 = 100.00$   
 $bo_2 = 190.00$   
 $ho_2 = 540.00$   
 $bi2_2 = 655400.00$   
 $\alpha_{se3} = 0$  (grid does not provide confinement)  
 $p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.0010472$

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00439823$   
 $p_{s1,x}(\text{column 1}) = (A_{s1}*h_1/s_1)/A_c = 0.00125664$   
 $h_1 = 600.00$   
 $A_{s1} = A_{stir1}*n_{s1} = 157.0796$   
 No stirups,  $n_{s1} = 2.00$   
 $p_{s2,x}(\text{column 2}) = (A_{s2}*h_2/s_2)/A_c = 0.00125664$   
 $h_2 = 600.00$   
 $A_{s2} = A_{stir2}*n_{s2} = 157.0796$   
 No stirups,  $n_{s2} = 2.00$   
 $p_{s3,x}(\text{web}) = (A_{s3}*h_3/s_3)/A_c = 0.00188496$   
 $h_3 = 1800.00$   
 $A_{s3} = A_{stir3}*n_{s3} = 0.00$   
 No stirups,  $n_{s3} = 2.00$

```

psh,y = ps1,y+ps2,y+ps3,y = 0.0010472
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.0005236
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.0005236
h2 = 250.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
h3 = 250.00
As3 = Astir3*ns3 = 157.0796
No stirups, ns3 = 0.00

```

```

Asec = 750000.00

```

```

s_1 = 100.00

```

```

s_2 = 100.00

```

```

s_3 = 200.00

```

```

fywe = 500.00

```

```

fce = 16.00

```

```

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

```

```

c = confinement factor = 1.00

```

```

y1 = 0.00208333

```

```

sh1 = 0.00805

```

```

ft1 = 600.00

```

```

fy1 = 500.00

```

```

su1 = 0.03226667

```

```

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

```

```

lo/lou,min = lb/ld = 1.00

```

```

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

```

```

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

```

```

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, ASCE41-17.

```

```

with fs1 = fs = 500.00

```

```

with Es1 = Es = 200000.00

```

```

y2 = 0.00208333

```

```

sh2 = 0.00805

```

```

ft2 = 600.00

```

```

fy2 = 500.00

```

```

su2 = 0.03226667

```

```

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

```

```

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

```

```

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

```

```

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

```

```

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, ASCE41-17.

```

```

with fs2 = fs = 500.00

```

```

with Es2 = Es = 200000.00

```

```

yv = 0.00208333

```

```

shv = 0.00805

```

```

ftv = 600.00

```

```

fyv = 500.00

```

```

suv = 0.03226667

```

```

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

```

```

lo/lou,min = lb/ld = 1.00

```

```

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667

```

```

From table 5A.1, TBDY: esuv_nominal = 0.08066667,

```

```

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

```

For calculation of  $\epsilon_{sv\_nominal}$  and  $\gamma_v$ ,  $\Delta v$ ,  $\Delta f_v$ ,  $\Delta f_y$ , it is considered characteristic value  $f_{sv} = f_{sv}/1.2$ , from table 5.1, TBDY.  
 $\gamma_1$ ,  $\Delta v_1$ ,  $\Delta f_{v1}$ ,  $\Delta f_{y1}$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE41-17.  
 with  $f_{sv} = f_s = 500.00$   
 with  $E_{sv} = E_s = 200000.00$   
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.11862785$   
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.11862785$   
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$

and confined core properties:

$b = 2940.00$   
 $d = 178.00$   
 $d' = 12.00$   
 $f_{cc} \text{ (5A.2, TBDY)} = 16.00$   
 $cc \text{ (5A.5, TBDY)} = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.14145031$   
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.14145031$   
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

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

--->

$\mu_u \text{ (4.9)} = 0.18965884$   
 $\mu_u = M_{Rc} \text{ (4.14)} = 2.4327E+008$   
 $u = \mu_u \text{ (4.1)} = 0.00019144$

Calculation of ratio  $l_b/l_d$

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

Calculation of  $\mu_u$ -

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

$u = 0.00019712$   
 $\mu_u = 3.1796E+008$

with full section properties:

$b = 3000.00$   
 $d = 208.00$   
 $d' = 42.00$   
 $v = 0.00275581$   
 $N = 27514.027$   
 $f_c = 16.00$   
 $cc \text{ (5A.5, TBDY)} = 0.002$   
 Final value of  $\mu_u$ :  $\mu_u^* = \text{shear\_factor} \cdot \text{Max}(\mu_u, cc) = 0.0035$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $\mu_u = 0.0035$   
 $w_e \text{ (5.4c)} = 0.00$   
 $ase \text{ ((5.4d), TBDY)} = (ase1 \cdot A_{col1} + ase2 \cdot A_{col2} + ase3 \cdot A_{web})/A_{sec} = 0.00$   
 $ase1 = 0.00$   
 $sh_1 = 100.00$   
 $bo_1 = 190.00$   
 $ho_1 = 540.00$   
 $bi2_1 = 655400.00$   
 $ase2 = 0.00$   
 $sh_2 = 100.00$   
 $bo_2 = 190.00$   
 $ho_2 = 540.00$   
 $bi2_2 = 655400.00$   
 $ase3 = 0 \text{ (grid does not provide confinement)}$   
 $psh_{min} = \text{Min}(psh_x, psh_y) = 0.0010472$

$psh,x = ps1,x + ps2,x + ps3,x = 0.00439823$   
 $ps1,x \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00125664$   
 $h1 = 600.00$   
 $As1 = Astir1 \cdot ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,x \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00125664$   
 $h2 = 600.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,x \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00188496$   
 $h3 = 1800.00$   
 $As3 = Astir3 \cdot ns3 = 0.00$   
 No stirups,  $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.0010472$   
 $ps1,y \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.0005236$   
 $h1 = 250.00$   
 $As1 = Astir1 \cdot ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.0005236$   
 $h2 = 250.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,y \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 \cdot ns3 = 157.0796$   
 No stirups,  $ns3 = 0.00$

$Asec = 750000.00$   
 $s_1 = 100.00$   
 $s_2 = 100.00$   
 $s_3 = 200.00$   
 $fywe = 500.00$   
 $fce = 16.00$

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

$y1 = 0.00208333$   
 $sh1 = 0.00805$

$ft1 = 600.00$   
 $fy1 = 500.00$

$su1 = 0.03226667$

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

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

$su1 = 0.4 \cdot esu1\_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fs1 = fs = 500.00$

with  $Es1 = Es = 200000.00$

$y2 = 0.00208333$

$sh2 = 0.00805$

$ft2 = 600.00$

$fy2 = 500.00$

$su2 = 0.03226667$

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

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

$su2 = 0.4 \cdot esu2\_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08066667$ ,

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, ASCE41-17.

```

with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785
2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785
v = Asl,mid/(b*d)*(fsv/fc) = 0.08055366
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031
2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031
v = Asl,mid/(b*d)*(fsv/fc) = 0.09605114
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.2130262
Mu = MRc (4.14) = 3.1796E+008
u = su (4.1) = 0.00019712

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 904830.218$

Calculation of Shear Strength at edge 1,  $V_{r1} = 904830.218$   
From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r1} = V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$   
 $\mu_u/\mu_u - l_w/2 = 0.00 \leq 0$   
= 1 (normal-weight concrete)  
 $f_c' = 16.00$ , but  $f_c'^{0.5} \leq 8.3 \text{ MPa}$  (22.5.3.1, ACI 318-14)  
h = 3000.00  
d = 200.00  
lw = 250.00  
Mu = 2.0446822E-012  
Vu = 2.0366709E-032  
Nu = 27514.027

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 251327.412$

$V_{s1} = 125663.706$  is calculated for pseudo-Column 1, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 100.00$$

$$f_y = 400.00$$

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

$V_{s2} = 125663.706$  is calculated for pseudo-Column 2, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 100.00$$

$$f_y = 400.00$$

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

$V_{s3} = 0.00$  is calculated for web, with:

$$d = 200.00$$

$$A_v = 0.00$$

$$s = 200.00$$

$$f_y = 400.00$$

$V_{s3}$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.00$$

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

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 1.5943E+006$$

$$b_w = 3000.00$$

Calculation of Shear Strength at edge 2,  $V_{r2} = 904830.218$

From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r2} = V_n < 0.83 \cdot f_c'^{0.5} \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$

$$\mu_u / V_u - l_w / 2 = 0.00 \leq 0$$

= 1 (normal-weight concrete)

$$f_c' = 16.00, \text{ but } f_c'^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$h = 3000.00$$

$$d = 200.00$$

$$l_w = 250.00$$

$$\mu_u = 2.0446822E-012$$

$$V_u = 2.0366709E-032$$

$$N_u = 27514.027$$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 251327.412$

$V_{s1} = 125663.706$  is calculated for pseudo-Column 1, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 100.00$$

$$f_y = 400.00$$

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

$V_{s2} = 125663.706$  is calculated for pseudo-Column 2, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 100.00$$

$$f_y = 400.00$$

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

$V_{s3} = 0.00$  is calculated for web, with:

$$d = 200.00$$

$$A_v = 0.00$$

$$s = 200.00$$

$$f_y = 400.00$$

$V_{s3}$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.00$$

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

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 1.5943E+006$$

$$b_w = 3000.00$$

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcrcws

#### Constant Properties

Knowledge Factor,  $\gamma = 1.00$

According to 10.7.2.3, ASCE 41-17, shear walls with

transverse reinforcement percentage,  $n < 0.0015$

are considered Force-Controlled and lower-bound strengths are used according to 7.5.1.3, ASCE 41-17

$n = 0.0010472$

with  $n = ps1 + ps2 + ps3$ , being the shear reinf. ratio in a plane perpendicular to the shear axis 3

(pseudo-col.1  $ps1 = As1*b1/s1 = (As1*h1/s1) / Ac = 0.0005236$

$h1 = 250.00$

$s1 = 100.00$

total area of hoops perpendicular to shear axis,  $As1 = 157.0796$

(pseudo-col.2  $ps2 = As2*b2/s2 = (As2*h2/s2) / Ac = 0.0005236$

$h2 = 250.00$

$s2 = 100.00$

total area of hoops perpendicular to shear axis,  $As2 = 157.0796$

(grid  $ps3 = As3*b3/s3 = (As3*h3/s3) / Ac = 0.00$

$h3 = 250.00$

$s3 = 200.00$

total area of hoops perpendicular to shear axis,  $As3 = 0.00$

total section area,  $Ac = 750000.00$

Consequently:

Existing material of Primary Member: Concrete Strength,  $fc = fc\_lower\_bound = 16.00$

Existing material of Primary Member: Steel Strength,  $fs = fs\_lower\_bound = 400.00$

Concrete Elasticity,  $Ec = 21019.039$

Steel Elasticity,  $Es = 200000.00$

Total Height,  $H_{tot} = 3000.00$

Edges Width,  $W_{edg} = 250.00$

Edges Height,  $H_{edg} = 600.00$

Web Width,  $W_{web} = 250.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

#### Stepwise Properties

Axial Force,  $F = -27598.912$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $As_t = 0.00$

-Compression:  $As_c = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{t,ten} = 2865.133$

-Compression:  $As_{c,com} = 2865.133$

-Middle:  $As_{mid} = 615.7522$

Mean Diameter of Tension Reinforcement,  $Db_L = 17.33333$

Considering wall controlled by Shear (shear control ratio  $> 1$ ),



interstorey drift provided values are calculated

Existing component: From table 7-7, ASCE 41\_17: Final interstorey drift Capacity  $u_R = \frac{1}{2} u = 0.004$   
from table 10-20:  $u = 0.004$

with:

- Condition i (shear wall and wall segments)

-  $(A_s - A_s') \cdot f_y + P / (t_w \cdot l_w \cdot f_c') = -0.209234$

$A_s = 0.00$

$A_s' = 6346.017$

$f_y = 400.00$

$P = 27598.912$

$t_w = 250.00$

$l_w = 3000.00$

$f_c = 16.00$

End Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (a)

## Calculation No. 7

wall W1, Floor 1

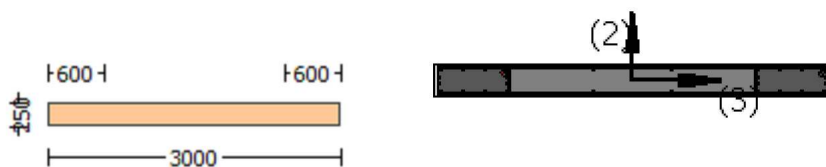
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity  $V_{Rd}$

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (b)

Section Type: rcrws

Constant Properties

Knowledge Factor,  $\phi = 1.00$   
 Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.  
 Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17  
 Consequently:  
 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,  $E_s = 200000.00$   
 Total Height,  $H_{tot} = 3000.00$   
 Edges Width,  $W_{edg} = 250.00$   
 Edges Height,  $H_{edg} = 600.00$   
 Web Width,  $W_{web} = 250.00$   
 Cover Thickness,  $c = 25.00$   
 Element Length,  $L = 3000.00$   
 Primary Member  
 Ribbed Bars  
 Ductile Steel  
 With Detailing for Earthquake Resistance (including stirrups closed at  $135^\circ$ )  
 Longitudinal Bars With Ends Lapped Starting at the End Sections  
 Adequate Lap Length ( $l_o/l_{ou,min} = l_b/l_d \geq 1$ )  
 No FRP Wrapping

#### Stepwise Properties

EDGE -A-  
 Bending Moment,  $M_a = 7.6264E+007$   
 Shear Force,  $V_a = -25423.336$   
 EDGE -B-  
 Bending Moment,  $M_b = 14301.377$   
 Shear Force,  $V_b = 25423.336$   
 BOTH EDGES  
 Axial Force,  $F = -27598.912$   
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
 -Tension:  $A_{st} = 0.00$   
 -Compression:  $A_{sc} = 6346.017$   
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
 -Tension:  $A_{st,ten} = 2865.133$   
 -Compression:  $A_{st,com} = 2865.133$   
 -Middle:  $A_{st,mid} = 615.7522$   
 Mean Diameter of Tension Reinforcement,  $Db_{L,ten} = 17.33333$

Existing component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $V_R = V_n = 1.7091E+006$   
 From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_n < 0.83 \cdot f_c'^{0.5} \cdot h \cdot d = 1.7091E+006$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653519.782$   
 $M_u/V_u - l_w/2 = -1499.437 \leq 0$   
 $= 1$  (normal-weight concrete)  
 $f_c' = 16.00$ , but  $f_c'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $h = 250.00$   
 $d = 2400.00$   
 $l_w = 3000.00$   
 $M_u = 14301.377$   
 $V_u = 25423.336$   
 $N_u = 27598.912$   
 From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0556E+006$   
 $V_{s1} = 301592.895$  is calculated for pseudo-Column 1, with:  
 $d = 480.00$   
 $A_v = 157079.633$   
 $s = 100.00$   
 $f_y = 400.00$

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

Vs2 = 301592.895 is calculated for pseudo-Column 2, with:

d = 480.00

Av = 157079.633

s = 100.00

fy = 400.00

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

Vs3 = 452389.342 is calculated for web, with:

d = 1440.00

Av = 157079.633

s = 200.00

fy = 400.00

Vs3 has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

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

From (11-11), ACI 440: Vs + Vf <= 1.5943E+006

bw = 250.00

End Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (b)

## Calculation No. 8

wall W1, Floor 1

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

Analysis: Uniform +X

Check: Chord rotation capacity ( u)

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcwrs

Constant Properties

```

Knowledge Factor,  $\gamma = 1.00$ 
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 16.00$ 
Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 400.00$ 
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
Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 500.00$ 
#####
Total Height,  $H_{tot} = 3000.00$ 
Edges Width,  $W_{edg} = 250.00$ 
Edges Height,  $H_{edg} = 600.00$ 
Web Width,  $W_{web} = 250.00$ 
Cover Thickness,  $c = 25.00$ 
Mean Confinement Factor overall section = 1.00
Element Length,  $L = 3000.00$ 
Primary Member
Ribbed Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ( $l_o/l_{ou,min} \geq 1$ )
No FRP Wrapping
-----

Stepwise Properties
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At local axis: 3
EDGE -A-
Shear Force,  $V_a = -3.6423187E-030$ 
EDGE -B-
Shear Force,  $V_b = 3.6423187E-030$ 
BOTH EDGES
Axial Force,  $F = -27514.027$ 
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension:  $A_{sl,t} = 0.00$ 
-Compression:  $A_{sl,c} = 6346.017$ 
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension:  $A_{sl,ten} = 2865.133$ 
-Compression:  $A_{sl,com} = 2865.133$ 
-Middle:  $A_{sl,mid} = 0.00$ 
(According to 10.7.2.3  $A_{sl,mid}$  is setted equal to zero)
-----
-----

Calculation of Shear Capacity ratio ,  $V_e/V_r = 2.25608$ 
Member Controlled by Shear ( $V_e/V_r > 1$ )
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n = 3.8558E+006$ 
with
 $M_{pr1} = \text{Max}(M_{u1+} , M_{u1-}) = 5.7837E+009$ 
 $M_{u1+} = 5.0210E+009$ , 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
 $M_{u1-} = 5.7837E+009$ , 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
 $M_{pr2} = \text{Max}(M_{u2+} , M_{u2-}) = 5.7837E+009$ 
 $M_{u2+} = 5.0210E+009$ , 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
 $M_{u2-} = 5.7837E+009$ , 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
-----

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

```

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

$$\phi_u = 1.1673539E-005$$

$$M_u = 5.0210E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear\_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.0035$$

$$\phi_{we} (5.4c) = 0.00$$

$$\phi_{ase} ((5.4d), TBDY) = (\phi_{ase1} * A_{col1} + \phi_{ase2} * A_{col2} + \phi_{ase3} * A_{web}) / A_{sec} = 0.00$$

$$\phi_{ase1} = 0.00$$

$$sh\_1 = 100.00$$

$$bo\_1 = 190.00$$

$$ho\_1 = 540.00$$

$$bi2\_1 = 655400.00$$

$$\phi_{ase2} = 0.00$$

$$sh\_2 = 100.00$$

$$bo\_2 = 190.00$$

$$ho\_2 = 540.00$$

$$bi2\_2 = 655400.00$$

$$\phi_{ase3} = 0 \text{ (grid does not provide confinement)}$$

$$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.0010472$$

$$\phi_{psh,x} = \phi_{ps1,x} + \phi_{ps2,x} + \phi_{ps3,x} = 0.00439823$$

$$\phi_{ps1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00125664$$

$$h_1 = 600.00$$

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

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

$$\phi_{ps2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00125664$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\phi_{ps3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirups, } n_{s3} = 2.00$$

$$\phi_{psh,y} = \phi_{ps1,y} + \phi_{ps2,y} + \phi_{ps3,y} = 0.0010472$$

$$\phi_{ps1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.0005236$$

$$h_1 = 250.00$$

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

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

$$\phi_{ps2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.0005236$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\phi_{ps3,y} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

$$\text{No stirups, } n_{s3} = 0.00$$

$$A_{sec} = 750000.00$$

$$s_1 = 100.00$$

$$s_2 = 100.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 500.00$$

$$f_{ce} = 16.00$$

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

```

c = confinement factor = 1.00
y1 = 0.00208333
sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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, ASCE41-17.
with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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, ASCE41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652
2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723
2 = Asl,com/(b*d)*(fs2/fc) = 0.16099723
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied

```

--->

$$su(4.9) = 0.06523978$$

$$\mu = M_{rc}(4.14) = 5.0210E+009$$

$$u = su(4.1) = 1.1673539E-005$$

Calculation of ratio  $l_b/l_d$

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

Calculation of  $\mu_1$ -

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

$$u = 1.1958028E-005$$

$$\mu = 5.7837E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear\_factor} * \text{Max}(c_u, c_c) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } c_u = 0.0035$$

$$w_e(5.4c) = 0.00$$

$$a_{se}((5.4d), TBDY) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 100.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 100.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$psh, \min = \text{Min}(psh, x, psh, y) = 0.0010472$$

$$psh, x = ps1, x + ps2, x + ps3, x = 0.00439823$$

$$ps1, x \text{ (column 1)} = (As1 * h1 / s_1) / A_c = 0.00125664$$

$$h1 = 600.00$$

$$As1 = A_{stir1} * ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2, x \text{ (column 2)} = (As2 * h2 / s_2) / A_c = 0.00125664$$

$$h2 = 600.00$$

$$As2 = A_{stir2} * ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3, x \text{ (web)} = (As3 * h3 / s_3) / A_c = 0.00188496$$

$$h3 = 1800.00$$

$$As3 = A_{stir3} * ns3 = 0.00$$

$$\text{No stirups, } ns3 = 2.00$$

$$psh, y = ps1, y + ps2, y + ps3, y = 0.0010472$$

$$ps1, y \text{ (column 1)} = (As1 * h1 / s_1) / A_c = 0.0005236$$

$$h1 = 250.00$$

$$As1 = A_{stir1} * ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2, y \text{ (column 2)} = (As2 * h2 / s_2) / A_c = 0.0005236$$

$$h2 = 250.00$$

$As2 = Astir2 * ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,y (web) = (As3 * h3 / s_3) / Ac = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 * ns3 = 157.0796$   
 No stirups,  $ns3 = 0.00$

-----

$Asec = 750000.00$

$s_1 = 100.00$

$s_2 = 100.00$

$s_3 = 200.00$

$fywe = 500.00$

$fce = 16.00$

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

$c =$  confinement factor  $= 1.00$

$y1 = 0.00208333$

$sh1 = 0.00805$

$ft1 = 600.00$

$fy1 = 500.00$

$su1 = 0.03226667$

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

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

$su1 = 0.4 * esu1\_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fs1 = fs = 500.00$

with  $Es1 = Es = 200000.00$

$y2 = 0.00208333$

$sh2 = 0.00805$

$ft2 = 600.00$

$fy2 = 500.00$

$su2 = 0.03226667$

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

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

$su2 = 0.4 * esu2\_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fs2 = fs = 500.00$

with  $Es2 = Es = 200000.00$

$yv = 0.00208333$

$shv = 0.00805$

$ftv = 600.00$

$fyv = 500.00$

$suv = 0.03226667$

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

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

$suv = 0.4 * esuv\_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY:  $esuv\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fsv = fs = 500.00$

with  $Esv = Es = 200000.00$

$1 = Asl,ten / (b * d) * (fs1 / fc) = 0.12111652$

$2 = Asl,com / (b * d) * (fs2 / fc) = 0.12111652$

$v = Asl,mid / (b * d) * (fsv / fc) = 0.02602943$



and confined core properties:

$$b = 190.00$$

$$d = 2927.00$$

$$d' = 13.00$$

$$fcc(5A.2, TBDY) = 16.00$$

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

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

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.16099723$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.16099723$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.03460028$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

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

--->

$$s_u(4.8) = 0.08747825$$

$$M_u = M_{Rc}(4.15) = 5.7837E+009$$

$$u = s_u(4.1) = 1.1958028E-005$$

Calculation of ratio  $l_b/d$

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

Calculation of  $M_{u2+}$

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

$$u = 1.1673539E-005$$

$$M_u = 5.0210E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, cc) = 0.0035$$

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

From (5.4b), TBDY:  $\phi_u = 0.0035$

$$\phi_{we}(5.4c) = 0.00$$

$$a_{se}((5.4d), TBDY) = (a_{se1}*A_{col1} + a_{se2}*A_{col2} + a_{se3}*A_{web})/A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 100.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 100.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$psh_{min} = \text{Min}(psh_x, psh_y) = 0.0010472$$

$$psh_x = ps1_x + ps2_x + ps3_x = 0.00439823$$

$$ps1_x(\text{column 1}) = (A_{s1}*h1/s_1)/A_c = 0.00125664$$

$$h1 = 600.00$$

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

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

$ps2,x \text{ (column 2)} = (As2 \cdot h2 / s\_2) / Ac = 0.00125664$   
 $h2 = 600.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,x \text{ (web)} = (As3 \cdot h3 / s\_3) / Ac = 0.00188496$   
 $h3 = 1800.00$   
 $As3 = Astir3 \cdot ns3 = 0.00$   
 No stirups,  $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.0010472$   
 $ps1,y \text{ (column 1)} = (As1 \cdot h1 / s\_1) / Ac = 0.0005236$   
 $h1 = 250.00$   
 $As1 = Astir1 \cdot ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,y \text{ (column 2)} = (As2 \cdot h2 / s\_2) / Ac = 0.0005236$   
 $h2 = 250.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,y \text{ (web)} = (As3 \cdot h3 / s\_3) / Ac = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 \cdot ns3 = 157.0796$   
 No stirups,  $ns3 = 0.00$

$Asec = 750000.00$   
 $s\_1 = 100.00$   
 $s\_2 = 100.00$   
 $s\_3 = 200.00$   
 $fywe = 500.00$   
 $fce = 16.00$   
 From ((5.A5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $y1 = 0.00208333$   
 $sh1 = 0.00805$   
 $ft1 = 600.00$   
 $fy1 = 500.00$   
 $su1 = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $Shear\_factor = 1.00$   
 $lo/lou,min = lb/ld = 1.00$   
 $su1 = 0.4 \cdot esu1\_nominal \text{ ((5.5), TBDY)} = 0.03226667$   
 From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,  
 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, ASCE41-17.  
 with  $fs1 = fs = 500.00$   
 with  $Es1 = Es = 200000.00$   
 $y2 = 0.00208333$   
 $sh2 = 0.00805$   
 $ft2 = 600.00$   
 $fy2 = 500.00$   
 $su2 = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $Shear\_factor = 1.00$   
 $lo/lou,min = lb/lb,min = 1.00$   
 $su2 = 0.4 \cdot esu2\_nominal \text{ ((5.5), TBDY)} = 0.03226667$   
 From table 5A.1, TBDY:  $esu2\_nominal = 0.08066667$ ,  
 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, ASCE41-17.  
 with  $fs2 = fs = 500.00$   
 with  $Es2 = Es = 200000.00$   
 $yv = 0.00208333$   
 $shv = 0.00805$   
 $ftv = 600.00$   
 $fyv = 500.00$

```

suv = 0.03226667
using (30) in Biskinis/Fardis (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/d = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652
2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723
2 = Asl,com/(b*d)*(fs2/fc) = 0.16099723
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.06523978
Mu = MRc (4.14) = 5.0210E+009
u = su (4.1) = 1.1673539E-005

```

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu2-

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

u = 1.1958028E-005

Mu = 5.7837E+009

with full section properties:

b = 250.00

d = 2957.00

d' = 43.00

v = 0.00232618

N = 27514.027

fc = 16.00

co (5A.5, TBDY) = 0.002

Final value of cu: cu\* = shear\_factor \* Max( cu, cc) = 0.0035

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

From (5.4b), TBDY: cu = 0.0035

we (5.4c) = 0.00

ase ((5.4d), TBDY) = (ase1\*Acol1+ase2\*Acol2+ase3\*Aweb)/Asec = 0.00

ase1 = 0.00

sh\_1 = 100.00

bo\_1 = 190.00

ho\_1 = 540.00

```

bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 100.00
bo_2 = 190.00
ho_2 = 540.00
bi2_2 = 655400.00
ase3 = 0 (grid does not provide confinement)
psh,min = Min(psh,x , psh,y) = 0.0010472

```

```

psh,x = ps1,x+ps2,x+ps3,x = 0.00439823
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00125664
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00125664
h2 = 600.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,x (web) = (As3*h3/s_3)/Ac = 0.00188496
h3 = 1800.00
As3 = Astir3*ns3 = 0.00
No stirups, ns3 = 2.00

```

```

psh,y = ps1,y+ps2,y+ps3,y = 0.0010472
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.0005236
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.0005236
h2 = 250.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
h3 = 250.00
As3 = Astir3*ns3 = 157.0796
No stirups, ns3 = 0.00

```

```

Asec = 750000.00
s_1 = 100.00
s_2 = 100.00
s_3 = 200.00
fywe = 500.00
fce = 16.00

```

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

```

y1 = 0.00208333
sh1 = 0.00805

```

```
ft1 = 600.00
```

```
fy1 = 500.00
```

```
su1 = 0.03226667
```

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

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

```
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
```

From table 5A.1, TBDY: esu1\_nominal = 0.08066667,

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, ASCE41-17.

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

```
y2 = 0.00208333
```

```
sh2 = 0.00805
```

```
ft2 = 600.00
```

```
fy2 = 500.00
```

```
su2 = 0.03226667
```

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

and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $l_o/l_{o,min} = l_b/l_{b,min} = 1.00$   
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.03226667$   
 From table 5A.1, TBDY:  $esu_{2,nominal} = 0.08066667$ ,  
 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  $Min(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE41-17.  
 with  $fs_2 = fs = 500.00$   
 with  $Es_2 = Es = 200000.00$   
 $y_v = 0.00208333$   
 $sh_v = 0.00805$   
 $ft_v = 600.00$   
 $fy_v = 500.00$   
 $suv = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $l_o/l_{o,min} = l_b/l_d = 1.00$   
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.03226667$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08066667$ ,  
 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  $Min(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE41-17.  
 with  $fsv = fs = 500.00$   
 with  $Es_v = Es = 200000.00$   
 $1 = Asl_{ten}/(b \cdot d) \cdot (fs_1/f_c) = 0.12111652$   
 $2 = Asl_{com}/(b \cdot d) \cdot (fs_2/f_c) = 0.12111652$   
 $v = Asl_{mid}/(b \cdot d) \cdot (fsv/f_c) = 0.02602943$   
 and confined core properties:  
 $b = 190.00$   
 $d = 2927.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 16.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl_{ten}/(b \cdot d) \cdot (fs_1/f_c) = 0.16099723$   
 $2 = Asl_{com}/(b \cdot d) \cdot (fs_2/f_c) = 0.16099723$   
 $v = Asl_{mid}/(b \cdot d) \cdot (fsv/f_c) = 0.03460028$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < v_{s,y_2}$  - LHS eq.(4.5) is not satisfied  
 --->  
 $v < v_{s,c}$  - RHS eq.(4.5) is satisfied  
 --->  
 $su (4.8) = 0.08747825$   
 $Mu = MRc (4.15) = 5.7837E+009$   
 $u = su (4.1) = 1.1958028E-005$

Calculation of ratio  $l_b/l_d$

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

Calculation of Shear Strength  $V_r = Min(V_{r1}, V_{r2}) = 1.7091E+006$

Calculation of Shear Strength at edge 1,  $V_{r1} = 1.7091E+006$   
 From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r1} = V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$   
 $\mu_u/V_u - l_w/2 = 0.00 \leq 0$   
 $= 1$  (normal-weight concrete)  
 $f'_c = 16.00$ , but  $f'_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $h = 250.00$   
 $d = 2400.00$   
 $l_w = 3000.00$   
 $\mu_u = 2.8146476E-010$   
 $V_u = 3.6423187E-030$   
 $N_u = 27514.027$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0556E+006$

$V_{s1} = 301592.895$  is calculated for pseudo-Column 1, with:

$d = 480.00$   
 $A_v = 157079.633$   
 $s = 100.00$   
 $f_y = 400.00$

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

$V_{s2} = 301592.895$  is calculated for pseudo-Column 2, with:

$d = 480.00$   
 $A_v = 157079.633$   
 $s = 100.00$   
 $f_y = 400.00$

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

$V_{s3} = 452389.342$  is calculated for web, with:

$d = 1440.00$   
 $A_v = 157079.633$   
 $s = 200.00$   
 $f_y = 400.00$

$V_{s3}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

$b_w = 250.00$

Calculation of Shear Strength at edge 2,  $V_{r2} = 1.7091E+006$

From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r2} = V_n < 0.83 \cdot f'_c^{0.5} \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$   
 $\mu_u/V_u - l_w/2 = 0.00 \leq 0$   
 $= 1$  (normal-weight concrete)  
 $f'_c = 16.00$ , but  $f'_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $h = 250.00$   
 $d = 2400.00$   
 $l_w = 3000.00$   
 $\mu_u = 2.8146476E-010$   
 $V_u = 3.6423187E-030$   
 $N_u = 27514.027$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0556E+006$

$V_{s1} = 301592.895$  is calculated for pseudo-Column 1, with:

$d = 480.00$   
 $A_v = 157079.633$   
 $s = 100.00$   
 $f_y = 400.00$

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

$V_{s2} = 301592.895$  is calculated for pseudo-Column 2, with:

$d = 480.00$   
 $A_v = 157079.633$   
 $s = 100.00$   
 $f_y = 400.00$

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

$V_{s3} = 452389.342$  is calculated for web, with:

$d = 1440.00$   
 $A_v = 157079.633$   
 $s = 200.00$   
 $f_y = 400.00$

Vs3 has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17, 10.3.4)  
Vf ((11-3)-(11.4), ACI 440) = 0.00  
From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$   
bw = 250.00

-----  
End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1  
At local axis: 3  
-----

Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1  
At Shear local axis: 2  
(Bending local axis: 3)  
Section Type: rcrcws

#### Constant Properties

-----  
Knowledge Factor,  $\gamma = 1.00$   
Mean strength values are used for both shear and moment calculations.  
Consequently:  
Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 16.00$   
Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 400.00$   
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  
Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 500.00$   
#####  
Total Height,  $H_{tot} = 3000.00$   
Edges Width,  $W_{edg} = 250.00$   
Edges Height,  $H_{edg} = 600.00$   
Web Width,  $W_{web} = 250.00$   
Cover Thickness,  $c = 25.00$   
Mean Confinement Factor overall section = 1.00  
Element Length,  $L = 3000.00$   
Primary Member  
Ribbed Bars  
Ductile Steel  
With Detailing for Earthquake Resistance (including stirrups closed at 135°)  
Longitudinal Bars With Ends Lapped Starting at the End Sections  
Adequate Lap Length ( $l_o/l_{ou,min} \geq 1$ )  
No FRP Wrapping  
-----

#### Stepwise Properties

-----  
At local axis: 2  
EDGE -A-  
Shear Force,  $V_a = -2.0366709E-032$   
EDGE -B-  
Shear Force,  $V_b = 2.0366709E-032$   
BOTH EDGES  
Axial Force,  $F = -27514.027$   
Longitudinal Reinforcement Area Distribution (in 2 divisions)  
-Tension:  $As_t = 0.00$   
-Compression:  $As_c = 6346.017$   
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $As_{t,ten} = 2368.761$   
-Compression:  $As_{c,com} = 2368.761$   
-Middle:  $As_{mid} = 0.00$   
(According to 10.7.2.3  $As_{mid}$  is setted equal to zero)  
-----  
-----

Calculation of Shear Capacity ratio ,  $V_e/V_r = 0.23426757$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n = 211972.373$

with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 3.1796\text{E}+008$

$M_{u1+} = 2.4327\text{E}+008$ , 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

$M_{u1-} = 3.1796\text{E}+008$ , 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

$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 3.1796\text{E}+008$

$M_{u2+} = 2.4327\text{E}+008$ , 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

$M_{u2-} = 3.1796\text{E}+008$ , 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

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

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

$\phi_u = 0.00019144$

$M_u = 2.4327\text{E}+008$   
-----

with full section properties:

$b = 3000.00$

$d = 208.00$

$d' = 42.00$

$v = 0.00275581$

$N = 27514.027$

$f_c = 16.00$

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

Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.0035$

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

From (5.4b), TBDY:  $\phi_u = 0.0035$

$w_e$  (5.4c) = 0.00

$a_{se} ((5.4d), \text{TBDY}) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$

$a_{se1} = 0.00$

$sh_1 = 100.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$a_{se2} = 0.00$

$sh_2 = 100.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$a_{se3} = 0$  (grid does not provide confinement)

$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.0010472$   
-----

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00439823$

$p_{s1,x}$  (column 1) =  $(A_{s1} * h_1 / s_1) / A_c = 0.00125664$

$h_1 = 600.00$

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

No stirups,  $n_{s1} = 2.00$

$p_{s2,x}$  (column 2) =  $(A_{s2} * h_2 / s_2) / A_c = 0.00125664$

$h_2 = 600.00$

$A_{s2} = A_{stir2} * n_{s2} = 157.0796$

No stirups,  $n_{s2} = 2.00$

$p_{s3,x}$  (web) =  $(A_{s3} * h_3 / s_3) / A_c = 0.00188496$

$h_3 = 1800.00$

$A_{s3} = A_{stir3} * n_{s3} = 0.00$

No stirups,  $n_{s3} = 2.00$   
-----

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.0010472$

$p_{s1,y}$  (column 1) =  $(A_{s1} * h_1 / s_1) / A_c = 0.0005236$

$h_1 = 250.00$



$As1 = Astir1 * ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,y \text{ (column 2)} = (As2 * h2 / s_2) / Ac = 0.0005236$   
 $h2 = 250.00$   
 $As2 = Astir2 * ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,y \text{ (web)} = (As3 * h3 / s_3) / Ac = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 * ns3 = 157.0796$   
 No stirups,  $ns3 = 0.00$

---

$Asec = 750000.00$   
 $s_1 = 100.00$   
 $s_2 = 100.00$   
 $s_3 = 200.00$   
 $fywe = 500.00$   
 $fce = 16.00$   
 From ((5.A5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $y1 = 0.00208333$   
 $sh1 = 0.00805$   
 $ft1 = 600.00$   
 $fy1 = 500.00$   
 $su1 = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $Shear\_factor = 1.00$   
 $lo/lou,min = lb/ld = 1.00$   
 $su1 = 0.4 * esu1\_nominal \text{ ((5.5), TBDY)} = 0.03226667$   
 From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,  
 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, ASCE41-17.  
 with  $fs1 = fs = 500.00$   
 with  $Es1 = Es = 200000.00$   
 $y2 = 0.00208333$   
 $sh2 = 0.00805$   
 $ft2 = 600.00$   
 $fy2 = 500.00$   
 $su2 = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $Shear\_factor = 1.00$   
 $lo/lou,min = lb/lb,min = 1.00$   
 $su2 = 0.4 * esu2\_nominal \text{ ((5.5), TBDY)} = 0.03226667$   
 From table 5A.1, TBDY:  $esu2\_nominal = 0.08066667$ ,  
 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, ASCE41-17.  
 with  $fs2 = fs = 500.00$   
 with  $Es2 = Es = 200000.00$   
 $yv = 0.00208333$   
 $shv = 0.00805$   
 $ftv = 600.00$   
 $fyv = 500.00$   
 $suv = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $Shear\_factor = 1.00$   
 $lo/lou,min = lb/ld = 1.00$   
 $suv = 0.4 * esuv\_nominal \text{ ((5.5), TBDY)} = 0.03226667$   
 From table 5A.1, TBDY:  $esuv\_nominal = 0.08066667$ ,  
 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, ASCE41-17.  
 with  $fsv = fs = 500.00$

```

with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785
2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031
2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18965884
Mu = MRc (4.14) = 2.4327E+008
u = su (4.1) = 0.00019144
-----

Calculation of ratio lb/d
-----
Adequate Lap Length: lb/d >= 1
-----
-----

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

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 0.00019712
Mu = 3.1796E+008
-----

with full section properties:
b = 3000.00
d = 208.00
d' = 42.00
v = 0.00275581
N = 27514.027
fc = 16.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0035
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0035
we (5.4c) = 0.00
ase ((5.4d), TBDY) = (ase1*Acol1+ase2*Acol2+ase3*Aweb)/Asec = 0.00
ase1 = 0.00
sh_1 = 100.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 100.00
bo_2 = 190.00
ho_2 = 540.00
bi2_2 = 655400.00
ase3 = 0 (grid does not provide confinement)
psh,min = Min(psh,x , psh,y) = 0.0010472
-----
psh,x = ps1,x+ps2,x+ps3,x = 0.00439823
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00125664
h1 = 600.00

```

$As1 = Astir1 * ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,x \text{ (column 2)} = (As2 * h2 / s_2) / Ac = 0.00125664$   
 $h2 = 600.00$   
 $As2 = Astir2 * ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,x \text{ (web)} = (As3 * h3 / s_3) / Ac = 0.00188496$   
 $h3 = 1800.00$   
 $As3 = Astir3 * ns3 = 0.00$   
 No stirups,  $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.0010472$   
 $ps1,y \text{ (column 1)} = (As1 * h1 / s_1) / Ac = 0.0005236$   
 $h1 = 250.00$   
 $As1 = Astir1 * ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,y \text{ (column 2)} = (As2 * h2 / s_2) / Ac = 0.0005236$   
 $h2 = 250.00$   
 $As2 = Astir2 * ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,y \text{ (web)} = (As3 * h3 / s_3) / Ac = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 * ns3 = 157.0796$   
 No stirups,  $ns3 = 0.00$

$Asec = 750000.00$   
 $s_1 = 100.00$   
 $s_2 = 100.00$   
 $s_3 = 200.00$   
 $fywe = 500.00$   
 $fce = 16.00$   
 From ((5.A5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $y1 = 0.00208333$   
 $sh1 = 0.00805$   
 $ft1 = 600.00$   
 $fy1 = 500.00$   
 $su1 = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou,min = lb/l_d = 1.00$   
 $su1 = 0.4 * esu1\_nominal \text{ ((5.5), TBDY)} = 0.03226667$   
 From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,  
 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, ASCE41-17.  
 with  $fs1 = fs = 500.00$   
 with  $Es1 = Es = 200000.00$   
 $y2 = 0.00208333$   
 $sh2 = 0.00805$   
 $ft2 = 600.00$   
 $fy2 = 500.00$   
 $su2 = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $\text{Shear\_factor} = 1.00$   
 $lo/lou,min = lb/l_b,min = 1.00$   
 $su2 = 0.4 * esu2\_nominal \text{ ((5.5), TBDY)} = 0.03226667$   
 From table 5A.1, TBDY:  $esu2\_nominal = 0.08066667$ ,  
 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, ASCE41-17.  
 with  $fs2 = fs = 500.00$   
 with  $Es2 = Es = 200000.00$   
 $yv = 0.00208333$   
 $shv = 0.00805$

```

ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785
2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785
v = Asl,mid/(b*d)*(fsv/fc) = 0.08055366
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031
2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031
v = Asl,mid/(b*d)*(fsv/fc) = 0.09605114
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.2130262
Mu = MRc (4.14) = 3.1796E+008
u = su (4.1) = 0.00019712

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

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

```

u = 0.00019144
Mu = 2.4327E+008

```

with full section properties:

```

b = 3000.00
d = 208.00
d' = 42.00
v = 0.00275581
N = 27514.027
fc = 16.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0035
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0035
we (5.4c) = 0.00
ase ((5.4d), TBDY) = (ase1*Acol1+ase2*Acol2+ase3*Aweb)/Asec = 0.00
ase1 = 0.00
sh_1 = 100.00

```

```

bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 100.00
bo_2 = 190.00
ho_2 = 540.00
bi2_2 = 655400.00
ase3 = 0 (grid does not provide confinement)
psh,min = Min(psh,x , psh,y) = 0.0010472

```

```

psh,x = ps1,x+ps2,x+ps3,x = 0.00439823
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00125664
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00125664
h2 = 600.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,x (web) = (As3*h3/s_3)/Ac = 0.00188496
h3 = 1800.00
As3 = Astir3*ns3 = 0.00
No stirups, ns3 = 2.00

```

```

psh,y = ps1,y+ps2,y+ps3,y = 0.0010472
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.0005236
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.0005236
h2 = 250.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
h3 = 250.00
As3 = Astir3*ns3 = 157.0796
No stirups, ns3 = 0.00

```

```

Asec = 750000.00
s_1 = 100.00
s_2 = 100.00
s_3 = 200.00
fywe = 500.00
fce = 16.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00208333
sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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, ASCE41-17.
with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00

```

```

su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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, ASCE41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785
2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031
2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
---->
v < vs,c - RHS eq.(4.5) is satisfied
---->
su (4.9) = 0.18965884
Mu = MRc (4.14) = 2.4327E+008
u = su (4.1) = 0.00019144

```

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu2-

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

u = 0.00019712  
Mu = 3.1796E+008

with full section properties:

$b = 3000.00$   
 $d = 208.00$   
 $d' = 42.00$   
 $v = 0.00275581$   
 $N = 27514.027$   
 $f_c = 16.00$   
 $\phi (5A.5, TBDY) = 0.002$   
 Final value of  $\phi$ :  $\phi^* = \text{shear\_factor} * \text{Max}(\phi, \phi_c) = 0.0035$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $\phi = 0.0035$   
 $\phi_w (5.4c) = 0.00$   
 $\phi_{se} ((5.4d), TBDY) = (\phi_{se1} * A_{col1} + \phi_{se2} * A_{col2} + \phi_{se3} * A_{web}) / A_{sec} = 0.00$   
 $\phi_{se1} = 0.00$   
 $s_{h1} = 100.00$   
 $b_{o1} = 190.00$   
 $h_{o1} = 540.00$   
 $b_{i21} = 655400.00$   
 $\phi_{se2} = 0.00$   
 $s_{h2} = 100.00$   
 $b_{o2} = 190.00$   
 $h_{o2} = 540.00$   
 $b_{i22} = 655400.00$   
 $\phi_{se3} = 0$  (grid does not provide confinement)  
 $\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.0010472$

$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00439823$   
 $\phi_{s1,x} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00125664$   
 $h_1 = 600.00$   
 $A_{s1} = A_{stir1} * n_{s1} = 157.0796$   
 No stirups,  $n_{s1} = 2.00$   
 $\phi_{s2,x} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00125664$   
 $h_2 = 600.00$   
 $A_{s2} = A_{stir2} * n_{s2} = 157.0796$   
 No stirups,  $n_{s2} = 2.00$   
 $\phi_{s3,x} (\text{web}) = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$   
 $h_3 = 1800.00$   
 $A_{s3} = A_{stir3} * n_{s3} = 0.00$   
 No stirups,  $n_{s3} = 2.00$

$\phi_{sh,y} = \phi_{s1,y} + \phi_{s2,y} + \phi_{s3,y} = 0.0010472$   
 $\phi_{s1,y} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.0005236$   
 $h_1 = 250.00$   
 $A_{s1} = A_{stir1} * n_{s1} = 157.0796$   
 No stirups,  $n_{s1} = 2.00$   
 $\phi_{s2,y} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.0005236$   
 $h_2 = 250.00$   
 $A_{s2} = A_{stir2} * n_{s2} = 157.0796$   
 No stirups,  $n_{s2} = 2.00$   
 $\phi_{s3,y} (\text{web}) = (A_{s3} * h_3 / s_3) / A_c = 0.00$   
 $h_3 = 250.00$   
 $A_{s3} = A_{stir3} * n_{s3} = 157.0796$   
 No stirups,  $n_{s3} = 0.00$

$A_{sec} = 750000.00$   
 $s_1 = 100.00$   
 $s_2 = 100.00$   
 $s_3 = 200.00$   
 $f_{ywe} = 500.00$   
 $f_{ce} = 16.00$   
 From ((5.A.5), TBDY), TBDY:  $\phi_c = 0.002$   
 $\phi_c = \text{confinement factor} = 1.00$   
 $y_1 = 0.00208333$   
 $s_{h1} = 0.00805$   
 $f_{t1} = 600.00$   
 $f_{y1} = 500.00$   
 $s_{u1} = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor

and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $su_1 = 0.4 * esu_{1,nominal} ((5.5), TBDY) = 0.03226667$   
 From table 5A.1, TBDY:  $esu_{1,nominal} = 0.08066667$ ,  
 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, ASCE41-17.  
 with  $fs_1 = fs = 500.00$   
 with  $Es_1 = Es = 200000.00$   
 $y_2 = 0.00208333$   
 $sh_2 = 0.00805$   
 $ft_2 = 600.00$   
 $fy_2 = 500.00$   
 $su_2 = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $l_o/l_{ou,min} = l_b/l_{b,min} = 1.00$   
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.03226667$   
 From table 5A.1, TBDY:  $esu_{2,nominal} = 0.08066667$ ,  
 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, ASCE41-17.  
 with  $fs_2 = fs = 500.00$   
 with  $Es_2 = Es = 200000.00$   
 $y_v = 0.00208333$   
 $sh_v = 0.00805$   
 $ft_v = 600.00$   
 $fy_v = 500.00$   
 $suv = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.03226667$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08066667$ ,  
 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, ASCE41-17.  
 with  $fsv = fs = 500.00$   
 with  $Esv = Es = 200000.00$   
 $1 = Asl_{ten}/(b * d) * (fs_1/fc) = 0.11862785$   
 $2 = Asl_{com}/(b * d) * (fs_2/fc) = 0.11862785$   
 $v = Asl_{mid}/(b * d) * (fsv/fc) = 0.08055366$   
 and confined core properties:  
 $b = 2940.00$   
 $d = 178.00$   
 $d' = 12.00$   
 $f_{cc} (5A.2, TBDY) = 16.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl_{ten}/(b * d) * (fs_1/fc) = 0.14145031$   
 $2 = Asl_{com}/(b * d) * (fs_2/fc) = 0.14145031$   
 $v = Asl_{mid}/(b * d) * (fsv/fc) = 0.09605114$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' does not satisfy Eq. (4.3)  
 --->  
 $v < v_{s,c}$  - RHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.2130262$   
 $Mu = MRc (4.14) = 3.1796E+008$   
 $u = su (4.1) = 0.00019712$

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



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

Calculation of Shear Strength  $V_r = \text{Min}(V_{r1}, V_{r2}) = 904830.218$

Calculation of Shear Strength at edge 1,  $V_{r1} = 904830.218$   
From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r1} = V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$

$\mu_u / \mu_u - l_w / 2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$ , but  $f_c'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$\mu_u = 2.0446822\text{E-}012$

$\mu_u = 2.0366709\text{E-}032$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 251327.412$

$V_{s1} = 125663.706$  is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s2} = 125663.706$  is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s3} = 0.00$  is calculated for web, with:

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 400.00$

$V_{s3}$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17, 10.3.4)

$2(1-s/d) = 0.00$

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943\text{E}+006$

$b_w = 3000.00$

Calculation of Shear Strength at edge 2,  $V_{r2} = 904830.218$

From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r2} = V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$

$\mu_u / \mu_u - l_w / 2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$ , but  $f_c'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$\mu_u = 2.0446822\text{E-}012$

$\mu_u = 2.0366709\text{E-}032$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 251327.412$

$V_{s1} = 125663.706$  is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

Vs2 = 125663.706 is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

Vs3 = 0.00 is calculated for web, with:

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 400.00$

Vs3 has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

$b_w = 3000.00$

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (b)

Section Type: rcrws

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

According to 10.7.2.3, ASCE 41-17, shear walls with

transverse reinforcement percentage,  $n < 0.0015$

are considered Force-Controlled and lower-bound strengths are used according to 7.5.1.3, ASCE 41-17

$n = 0.0010472$

with  $n = \rho_{s1} + \rho_{s2} + \rho_{s3}$ , being the shear reinf. ratio in a plane perpendicular to the shear axis 2

(pseudo-col.1  $\rho_{s1} = A_{s1} \cdot b_1 / s_1 = (A_{s1} \cdot h_1 / s_1) / A_c = 0.0005236$

$h_1 = 250.00$

$s_1 = 100.00$

total area of hoops perpendicular to shear axis,  $A_{s1} = 157.0796$

(pseudo-col.2  $\rho_{s2} = A_{s2} \cdot b_2 / s_2 = (A_{s2} \cdot h_2 / s_2) / A_c = 0.0005236$

$h_2 = 250.00$

$s_2 = 100.00$

total area of hoops perpendicular to shear axis,  $A_{s2} = 157.0796$

(grid  $\rho_{s3} = A_{s3} \cdot b_3 / s_3 = (A_{s3} \cdot h_3 / s_3) / A_c = 0.00$

$h_3 = 250.00$

$s_3 = 200.00$

total area of hoops perpendicular to shear axis,  $A_{s3} = 0.00$

total section area,  $A_c = 750000.00$

Consequently:

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,  $E_s = 200000.00$

Total Height,  $H_{tot} = 3000.00$

Edges Width,  $W_{edg} = 250.00$

Edges Height,  $H_{edg} = 600.00$

Web Width,  $W_{web} = 250.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars  
 Ductile Steel  
 With Detailing for Earthquake Resistance (including stirrups closed at 135°)  
 Longitudinal Bars With Ends Lapped Starting at the End Sections  
 Adequate Lap Length ( $l_b/l_d \geq 1$ )  
 No FRP Wrapping

#### Stepwise Properties

Bending Moment,  $M = -6.2019971E-011$   
 Shear Force,  $V_2 = 6.3979846E-014$   
 Shear Force,  $V_3 = 25423.336$   
 Axial Force,  $F = -27598.912$   
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
   -Tension:  $As_t = 0.00$   
   -Compression:  $As_c = 6346.017$   
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $As_{t,ten} = 2368.761$   
   -Compression:  $As_{c,com} = 2368.761$   
   -Middle:  $As_{mid} = 1608.495$   
 Mean Diameter of Tension Reinforcement,  $Db_L = 17.20$

Existing component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $\phi_{u,R} = \phi_u = 0.00385818$   
 $\phi_u = \phi_y + \phi_p = 0.00385818$

- Calculation of  $\phi_y$  -

$\phi_y = (M_y \cdot I_p) / (E I)_{Eff} = 0.00185818$  ((10-5), ASCE 41-17))  
 $M_y = 2.2249E+008$   
 $(E I)_{Eff} = 0.35 \cdot E_c \cdot I$  (table 10-5)  
 $E_c \cdot I = 8.2106E+013$   
 $I_p = 0.5 \cdot d = 0.5 \cdot (0.8 \cdot h) = 240.00$

#### Calculation of Yielding Moment $M_y$

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

$\phi_y = \min(\phi_{y,ten}, \phi_{y,com})$   
 $\phi_{y,ten} = 1.2992433E-005$   
 with  $f_y = 400.00$   
 $d = 208.00$   
 $\phi_y = 0.25992422$   
 $A = 0.01028047$   
 $B = 0.00622229$   
 with  $p_t = 0.00379609$   
 $p_c = 0.00379609$   
 $p_v = 0.00257772$   
 $N = 27598.912$   
 $b = 3000.00$   
 $\phi_y = 0.20192308$   
 $\phi_{y,comp} = 2.5448441E-005$   
 with  $f_c = 16.00$   
 $E_c = 21019.039$   
 $\phi_y = 0.25885414$   
 $A = 0.0100085$   
 $B = 0.00611172$   
 with  $E_s = 200000.00$

Calculation of ratio  $l_b/l_d$

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

- Calculation of  $p$  -

Considering wall controlled by flexure (shear control ratio  $\leq 1$ ),  
from table 10-19:  $p = 0.002$

with:

- Condition i (shear wall and wall segments)

-  $(A_s - A_s') \cdot f_y + P / (t_w \cdot l_w \cdot f_c') = -0.209234$

$A_s = 0.00$

$A_s' = 6346.017$

$f_y = 400.00$

$P = 27598.912$

$t_w = 3000.00$

$l_w = 250.00$

$f_c = 16.00$

-  $V / (t_w \cdot l_w \cdot f_c^{0.5}) = 2.5682965E-019$ , NOTE: units in lb & in

- Confined Boundary: No

Boundary hoops spacing does not exceed  $8d_b$  ( $s_1 < 8 \cdot d_b$  and  $s_2 < 8 \cdot d_b$ )

Boundary Trans. Reinf. does not exceed 50% of ACI 318 provision ( $V_{w1} + V_{w2} > 0.50 \cdot (V - V_c - V_{w3})$ )

With

Boundary Element 1:

$V_{w1} = 125663.706$

$s_1 = 100.00$

Boundary Element 2:

$V_{w2} = 125663.706$

$s_2 = 100.00$

Grid Shear Force,  $V_{w3} = 0.00$

Concrete Shear Force,  $V_c = 192366.559$

(The variables above have already been given in Shear control ratio calculation)

Mean diameter of all bars,  $d_b = 17.33333$

Design Shear Force,  $V = 6.3979846E-014$

End Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (b)

## Calculation No. 9

wall W1, Floor 1

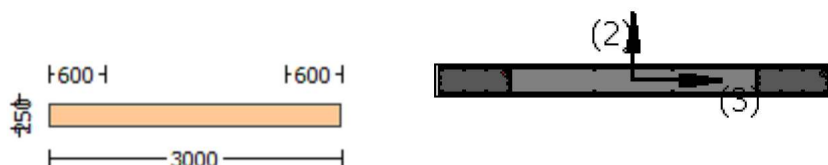
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity  $V_{Rd}$

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcw

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.

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

Consequently:

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,  $E_s = 200000.00$

Total Height,  $H_{tot} = 3000.00$

Edges Width,  $W_{edg} = 250.00$

Edges Height,  $H_{edg} = 600.00$

Web Width,  $W_{web} = 250.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment,  $M_a = -1.6181356E-010$

Shear Force,  $V_a = -7.9731059E-014$

EDGE -B-

Bending Moment,  $M_b = -7.7792062E-011$

Shear Force,  $V_b = 7.9731059E-014$

BOTH EDGES

Axial Force,  $F = -27619.81$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $A_{sl,t} = 0.00$

-Compression:  $A_{sl,c} = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $A_{sl,ten} = 2368.761$

-Compression:  $A_{sl,com} = 2368.761$

-Middle:  $A_{sl,mid} = 1608.495$

Mean Diameter of Tension Reinforcement,  $Db_{L,ten} = 17.20$

Existing component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $V_R = V_n = 403411.971$   
From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_n < 0.83 \cdot f_c' \cdot h \cdot d = 403411.971$

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

From Table (11.5.4.6(d-e)), ACI 318-14:  $V_c = 152084.559$

$\mu_u / \mu - l_w / 2 = 1904.492 > 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$ , but  $f_c'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$\mu_u = 1.6181356E-010$

$V_u = 7.9731059E-014$

$N_u = 27619.81$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 251327.412$

$V_{s1} = 125663.706$  is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s2} = 125663.706$  is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s3} = 0.00$  is calculated for web, with:

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 400.00$

$V_{s3}$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

$b_w = 3000.00$

End Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (a)

**Calculation No. 10**

wall W1, Floor 1

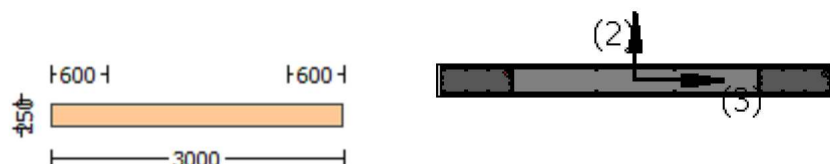
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity ( $\phi_r$ )

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcwrs

Constant Properties

Knowledge Factor,  $K = 1.00$

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

Consequently:

Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 16.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 400.00$

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

Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 500.00$

#####

Total Height,  $H_{tot} = 3000.00$

Edges Width,  $W_{edg} = 250.00$

Edges Height,  $H_{edg} = 600.00$

Web Width,  $W_{web} = 250.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force,  $V_a = -3.6423187\text{E}-030$

EDGE -B-

Shear Force,  $V_b = 3.6423187\text{E}-030$

BOTH EDGES

Axial Force,  $F = -27514.027$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $As_t = 0.00$

-Compression:  $As_c = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{t,ten} = 2865.133$

-Compression:  $As_{c,com} = 2865.133$

-Middle:  $As_{mid} = 0.00$

(According to 10.7.2.3  $As_{mid}$  is setted equal to zero)

Calculation of Shear Capacity ratio,  $V_e/V_r = 2.25608$

Member Controlled by Shear ( $V_e/V_r > 1$ )

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n = 3.8558\text{E}+006$  with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 5.7837\text{E}+009$

$M_{u1+} = 5.0210\text{E}+009$ , 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

$M_{u1-} = 5.7837\text{E}+009$ , 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

$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 5.7837\text{E}+009$

$M_{u2+} = 5.0210\text{E}+009$ , 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

$M_{u2-} = 5.7837\text{E}+009$ , 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

Calculation of  $M_{u1+}$

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

$\phi_u = 1.1673539\text{E}-005$

$M_u = 5.0210\text{E}+009$

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$

$v = 0.00232618$

$N = 27514.027$

$f_c = 16.00$

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

Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.0035$

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

From (5.4b), TBDY:  $\phi_u = 0.0035$

$\phi_{we}$  (5.4c) = 0.00

$\phi_{ase} ((5.4d), \text{TBDY}) = (\phi_{ase1} * A_{col1} + \phi_{ase2} * A_{col2} + \phi_{ase3} * A_{web}) / A_{sec} = 0.00$

$\phi_{ase1} = 0.00$

$\phi_{sh\_1} = 100.00$

$\phi_{bo\_1} = 190.00$

$\phi_{ho\_1} = 540.00$

$\phi_{bi2\_1} = 655400.00$

$\phi_{ase2} = 0.00$

$\phi_{sh\_2} = 100.00$

$\phi_{bo\_2} = 190.00$

$\phi_{ho\_2} = 540.00$

$\phi_{bi2\_2} = 655400.00$

$\phi_{ase3} = 0$  (grid does not provide confinement)

$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.0010472$



$psh,x = ps1,x + ps2,x + ps3,x = 0.00439823$   
 $ps1,x \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00125664$   
 $h1 = 600.00$   
 $As1 = Astir1 \cdot ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,x \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00125664$   
 $h2 = 600.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,x \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00188496$   
 $h3 = 1800.00$   
 $As3 = Astir3 \cdot ns3 = 0.00$   
 No stirups,  $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.0010472$   
 $ps1,y \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.0005236$   
 $h1 = 250.00$   
 $As1 = Astir1 \cdot ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.0005236$   
 $h2 = 250.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,y \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 \cdot ns3 = 157.0796$   
 No stirups,  $ns3 = 0.00$

$Asec = 750000.00$   
 $s_1 = 100.00$   
 $s_2 = 100.00$   
 $s_3 = 200.00$   
 $fywe = 500.00$   
 $fce = 16.00$

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

$y1 = 0.00208333$   
 $sh1 = 0.00805$   
 $ft1 = 600.00$   
 $fy1 = 500.00$   
 $su1 = 0.03226667$

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

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

$su1 = 0.4 \cdot esu1\_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fs1 = fs = 500.00$

with  $Es1 = Es = 200000.00$

$y2 = 0.00208333$   
 $sh2 = 0.00805$   
 $ft2 = 600.00$   
 $fy2 = 500.00$   
 $su2 = 0.03226667$

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

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

$su2 = 0.4 \cdot esu2\_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fs2 = fs = 500.00$

```

with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652
2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723
2 = Asl,com/(b*d)*(fs2/fc) = 0.16099723
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.06523978
Mu = MRc (4.14) = 5.0210E+009
u = su (4.1) = 1.1673539E-005

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

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

```

u = 1.1958028E-005
Mu = 5.7837E+009

```

with full section properties:

```

b = 250.00
d = 2957.00
d' = 43.00
v = 0.00232618
N = 27514.027
fc = 16.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0035
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0035
we (5.4c) = 0.00

```

$$ase((5.4d), TBDY) = (ase1 \cdot Acol1 + ase2 \cdot Acol2 + ase3 \cdot Aweb) / Asec = 0.00$$

$$ase1 = 0.00$$

$$sh_1 = 100.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$ase2 = 0.00$$

$$sh_2 = 100.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$ase3 = 0 \text{ (grid does not provide confinement)}$$

$$psh,min = \min(psh,x, psh,y) = 0.0010472$$

$$psh,x = ps1,x + ps2,x + ps3,x = 0.00439823$$

$$ps1,x \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00125664$$

$$h1 = 600.00$$

$$As1 = Astir1 \cdot ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2,x \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00125664$$

$$h2 = 600.00$$

$$As2 = Astir2 \cdot ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3,x \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00188496$$

$$h3 = 1800.00$$

$$As3 = Astir3 \cdot ns3 = 0.00$$

$$\text{No stirups, } ns3 = 2.00$$

$$psh,y = ps1,y + ps2,y + ps3,y = 0.0010472$$

$$ps1,y \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.0005236$$

$$h1 = 250.00$$

$$As1 = Astir1 \cdot ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.0005236$$

$$h2 = 250.00$$

$$As2 = Astir2 \cdot ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3,y \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00$$

$$h3 = 250.00$$

$$As3 = Astir3 \cdot ns3 = 157.0796$$

$$\text{No stirups, } ns3 = 0.00$$

$$Asec = 750000.00$$

$$s_1 = 100.00$$

$$s_2 = 100.00$$

$$s_3 = 200.00$$

$$fywe = 500.00$$

$$fce = 16.00$$

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

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

$$y1 = 0.00208333$$

$$sh1 = 0.00805$$

$$ft1 = 600.00$$

$$fy1 = 500.00$$

$$su1 = 0.03226667$$

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

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

$$su1 = 0.4 \cdot esu1\_nominal \text{ ((5.5), TBDY)} = 0.03226667$$

$$\text{From table 5A.1, TBDY: } esu1\_nominal = 0.08066667,$$

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  $\min(1, 1.25 \cdot (lb/l_d)^{2/3})$ , from 10.3.5, ASCE41-17.

$$\text{with } fs1 = fs = 500.00$$

$$\text{with } Es1 = Es = 200000.00$$

$$y2 = 0.00208333$$

```

sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb,min = 1.00
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
    From table 5A.1, TBDY: esu2_nominal = 0.08066667,
    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, ASCE41-17.
    with fs2 = fs = 500.00
    with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb = 1.00
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
    From table 5A.1, TBDY: esuv_nominal = 0.08066667,
    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, ASCE41-17.
    with fsv = fs = 500.00
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652
2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652
v = Asl,mid/(b*d)*(fsv/fc) = 0.02602943
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723
2 = Asl,com/(b*d)*(fs2/fc) = 0.16099723
v = Asl,mid/(b*d)*(fsv/fc) = 0.03460028
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.8) = 0.08747825
Mu = MRc (4.15) = 5.7837E+009
u = su (4.1) = 1.1958028E-005

```

Calculation of ratio lb/lb

Adequate Lap Length: lb/lb >= 1

Calculation of Mu2+

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

$$u = 1.1673539E-005$$

$$\mu = 5.0210E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.0035$$

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

$$\text{From (5.4b), TB DY: } \phi_u = 0.0035$$

$$w_e (5.4c) = 0.00$$

$$a_{se} ((5.4d), \text{TB DY}) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 100.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 100.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$psh_{min} = \text{Min}(psh_x, psh_y) = 0.0010472$$

$$psh_x = ps1_x + ps2_x + ps3_x = 0.00439823$$

$$ps1_x \text{ (column 1)} = (A_{s1} * h1 / s_1) / A_c = 0.00125664$$

$$h1 = 600.00$$

$$A_{s1} = A_{stir1} * ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2_x \text{ (column 2)} = (A_{s2} * h2 / s_2) / A_c = 0.00125664$$

$$h2 = 600.00$$

$$A_{s2} = A_{stir2} * ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3_x \text{ (web)} = (A_{s3} * h3 / s_3) / A_c = 0.00188496$$

$$h3 = 1800.00$$

$$A_{s3} = A_{stir3} * ns3 = 0.00$$

$$\text{No stirups, } ns3 = 2.00$$

$$psh_y = ps1_y + ps2_y + ps3_y = 0.0010472$$

$$ps1_y \text{ (column 1)} = (A_{s1} * h1 / s_1) / A_c = 0.0005236$$

$$h1 = 250.00$$

$$A_{s1} = A_{stir1} * ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2_y \text{ (column 2)} = (A_{s2} * h2 / s_2) / A_c = 0.0005236$$

$$h2 = 250.00$$

$$A_{s2} = A_{stir2} * ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3_y \text{ (web)} = (A_{s3} * h3 / s_3) / A_c = 0.00$$

$$h3 = 250.00$$

$$A_{s3} = A_{stir3} * ns3 = 157.0796$$

$$\text{No stirups, } ns3 = 0.00$$

$$A_{sec} = 750000.00$$

$$s_1 = 100.00$$

$$s_2 = 100.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 500.00$$

$$f_{ce} = 16.00$$

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

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

$$y1 = 0.00208333$$

```

sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 1.00
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
    From table 5A.1, TBDY: esu1_nominal = 0.08066667,
    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, ASCE41-17.
    with fs1 = fs = 500.00
    with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 1.00
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
    From table 5A.1, TBDY: esu2_nominal = 0.08066667,
    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, ASCE41-17.
    with fs2 = fs = 500.00
    with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 1.00
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
    From table 5A.1, TBDY: esuv_nominal = 0.08066667,
    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, ASCE41-17.
    with fsv = fs = 500.00
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652
2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723
    2 = Asl,com/(b*d)*(fs2/fc) = 0.16099723
    v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.06523978

```

$$\begin{aligned} \mu_u &= M/R_c(4.14) = 5.0210E+009 \\ u &= s_u(4.1) = 1.1673539E-005 \end{aligned}$$

Calculation of ratio  $I_b/I_d$

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

Calculation of  $\mu_u$

Calculation of ultimate curvature  $\mu_u$  according to 4.1, Biskinis/Fardis 2013:  
 $\mu_u = 1.1958028E-005$   
 $\mu_u = 5.7837E+009$

with full section properties:

$$\begin{aligned} b &= 250.00 \\ d &= 2957.00 \\ d' &= 43.00 \\ v &= 0.00232618 \\ N &= 27514.027 \\ f_c &= 16.00 \\ c_o(5A.5, TBDY) &= 0.002 \\ \text{Final value of } \mu_u: \mu_u^* &= \text{shear\_factor} * \text{Max}(\mu_u, c_o) = 0.0035 \\ \text{The Shear\_factor is considered equal to 1 (pure moment strength)} \\ \text{From (5.4b), TBDY: } \mu_u &= 0.0035 \\ w_e(5.4c) &= 0.00 \\ a_{se}((5.4d), TBDY) &= (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00 \\ a_{se1} &= 0.00 \\ sh_1 &= 100.00 \\ bo_1 &= 190.00 \\ ho_1 &= 540.00 \\ bi2_1 &= 655400.00 \\ a_{se2} &= 0.00 \\ sh_2 &= 100.00 \\ bo_2 &= 190.00 \\ ho_2 &= 540.00 \\ bi2_2 &= 655400.00 \\ a_{se3} &= 0 \text{ (grid does not provide confinement)} \\ p_{sh,min} &= \text{Min}(p_{sh,x}, p_{sh,y}) = 0.0010472 \end{aligned}$$

$$\begin{aligned} p_{sh,x} &= p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00439823 \\ p_{s1,x}(\text{column 1}) &= (A_{s1} * h_1 / s_1) / A_c = 0.00125664 \\ h_1 &= 600.00 \\ A_{s1} &= A_{stir1} * n_{s1} = 157.0796 \\ \text{No stirups, } n_{s1} &= 2.00 \\ p_{s2,x}(\text{column 2}) &= (A_{s2} * h_2 / s_2) / A_c = 0.00125664 \\ h_2 &= 600.00 \\ A_{s2} &= A_{stir2} * n_{s2} = 157.0796 \\ \text{No stirups, } n_{s2} &= 2.00 \\ p_{s3,x}(\text{web}) &= (A_{s3} * h_3 / s_3) / A_c = 0.00188496 \\ h_3 &= 1800.00 \\ A_{s3} &= A_{stir3} * n_{s3} = 0.00 \\ \text{No stirups, } n_{s3} &= 2.00 \end{aligned}$$

$$\begin{aligned} p_{sh,y} &= p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.0010472 \\ p_{s1,y}(\text{column 1}) &= (A_{s1} * h_1 / s_1) / A_c = 0.0005236 \\ h_1 &= 250.00 \\ A_{s1} &= A_{stir1} * n_{s1} = 157.0796 \\ \text{No stirups, } n_{s1} &= 2.00 \\ p_{s2,y}(\text{column 2}) &= (A_{s2} * h_2 / s_2) / A_c = 0.0005236 \\ h_2 &= 250.00 \\ A_{s2} &= A_{stir2} * n_{s2} = 157.0796 \\ \text{No stirups, } n_{s2} &= 2.00 \end{aligned}$$

$$ps_{3,y}(\text{web}) = (As_3 \cdot h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$As_3 = Astir_3 \cdot ns_3 = 157.0796$$

$$\text{No stirrups, } ns_3 = 0.00$$

$$A_{sec} = 750000.00$$

$$s_1 = 100.00$$

$$s_2 = 100.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 500.00$$

$$f_{ce} = 16.00$$

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

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

$$y_1 = 0.00208333$$

$$sh_1 = 0.00805$$

$$ft_1 = 600.00$$

$$fy_1 = 500.00$$

$$su_1 = 0.03226667$$

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

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

$$su_1 = 0.4 \cdot esu_{1,nominal} ((5.5), \text{TBDY}) = 0.03226667$$

$$\text{From table 5A.1, TBDY: } esu_{1,nominal} = 0.08066667,$$

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  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE41-17.

$$\text{with } fs_1 = fs = 500.00$$

$$\text{with } Es_1 = Es = 200000.00$$

$$y_2 = 0.00208333$$

$$sh_2 = 0.00805$$

$$ft_2 = 600.00$$

$$fy_2 = 500.00$$

$$su_2 = 0.03226667$$

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

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

$$su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), \text{TBDY}) = 0.03226667$$

$$\text{From table 5A.1, TBDY: } esu_{2,nominal} = 0.08066667,$$

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

$y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE41-17.

$$\text{with } fs_2 = fs = 500.00$$

$$\text{with } Es_2 = Es = 200000.00$$

$$y_v = 0.00208333$$

$$sh_v = 0.00805$$

$$ft_v = 600.00$$

$$fy_v = 500.00$$

$$suv = 0.03226667$$

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

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

$$suv = 0.4 \cdot esuv_{nominal} ((5.5), \text{TBDY}) = 0.03226667$$

$$\text{From table 5A.1, TBDY: } esuv_{nominal} = 0.08066667,$$

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

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

$y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE41-17.

$$\text{with } fsv = fs = 500.00$$

$$\text{with } Es_v = Es = 200000.00$$

$$1 = Asl, \text{ten} / (b \cdot d) \cdot (fs_1 / f_c) = 0.12111652$$

$$2 = Asl, \text{com} / (b \cdot d) \cdot (fs_2 / f_c) = 0.12111652$$

$$v = Asl, \text{mid} / (b \cdot d) \cdot (fsv / f_c) = 0.02602943$$

and confined core properties:

$$b = 190.00$$



$d = 2927.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 16.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.16099723$   
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.16099723$   
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.03460028$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)

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

$su (4.8) = 0.08747825$   
 $\mu_u = MR_c (4.15) = 5.7837E+009$   
 $u = su (4.1) = 1.1958028E-005$

Calculation of ratio  $l_b/d$

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

Calculation of Shear Strength  $V_r = \min(V_{r1}, V_{r2}) = 1.7091E+006$

Calculation of Shear Strength at edge 1,  $V_{r1} = 1.7091E+006$   
 From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r1} = V_n < 0.83*f'_c^{0.5}*h*d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$   
 $\mu_u/V_u - l_w/2 = 0.00 \leq 0$

$= 1$  (normal-weight concrete)  
 $f'_c = 16.00$ , but  $f_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $h = 250.00$   
 $d = 2400.00$   
 $l_w = 3000.00$   
 $\mu_u = 2.8146476E-010$   
 $V_u = 3.6423187E-030$   
 $N_u = 27514.027$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0556E+006$

$V_{s1} = 301592.895$  is calculated for pseudo-Column 1, with:

$d = 480.00$   
 $A_v = 157079.633$   
 $s = 100.00$   
 $f_y = 400.00$

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

$V_{s2} = 301592.895$  is calculated for pseudo-Column 2, with:

$d = 480.00$   
 $A_v = 157079.633$   
 $s = 100.00$   
 $f_y = 400.00$

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

$V_{s3} = 452389.342$  is calculated for web, with:

$d = 1440.00$   
 $A_v = 157079.633$   
 $s = 200.00$   
 $f_y = 400.00$

$V_{s3}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

$bw = 250.00$

Calculation of Shear Strength at edge 2,  $V_{r2} = 1.7091E+006$   
From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r2} = V_n < 0.83 \cdot f_c' \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$

$\mu_u / \mu - l_w / 2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$ , but  $f_c'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 2.8146476E-010$

$V_u = 3.6423187E-030$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0556E+006$

$V_{s1} = 301592.895$  is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s2} = 301592.895$  is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s3} = 452389.342$  is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 400.00$

$V_{s3}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

$b_w = 250.00$

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1  
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcrcws

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

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

Consequently:

Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 16.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 400.00$

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

Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 500.00$

#####

Total Height,  $H_{tot} = 3000.00$

Edges Width,  $W_{edg} = 250.00$

Edges Height,  $H_{edg} = 600.00$   
 Web Width,  $W_{web} = 250.00$   
 Cover Thickness,  $c = 25.00$   
 Mean Confinement Factor overall section = 1.00  
 Element Length,  $L = 3000.00$   
 Primary Member  
 Ribbed Bars  
 Ductile Steel  
 With Detailing for Earthquake Resistance (including stirrups closed at  $135^\circ$ )  
 Longitudinal Bars With Ends Lapped Starting at the End Sections  
 Adequate Lap Length ( $l_o/l_{ou,min} > 1$ )  
 No FRP Wrapping

#### Stepwise Properties

At local axis: 2  
 EDGE -A-  
 Shear Force,  $V_a = -2.0366709E-032$   
 EDGE -B-  
 Shear Force,  $V_b = 2.0366709E-032$   
 BOTH EDGES  
 Axial Force,  $F = -27514.027$   
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
   -Tension:  $As_t = 0.00$   
   -Compression:  $As_c = 6346.017$   
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $As_{t,ten} = 2368.761$   
   -Compression:  $As_{c,com} = 2368.761$   
   -Middle:  $As_{mid} = 0.00$   
 (According to 10.7.2.3  $As_{mid}$  is setted equal to zero)

Calculation of Shear Capacity ratio,  $V_e/V_r = 0.23426757$   
 Member Controlled by Flexure ( $V_e/V_r < 1$ )  
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n = 211972.373$   
 with  
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 3.1796E+008$   
 $\mu_{u1+} = 2.4327E+008$ , 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  
 $\mu_{u1-} = 3.1796E+008$ , is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination  
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 3.1796E+008$   
 $\mu_{u2+} = 2.4327E+008$ , is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination  
 $\mu_{u2-} = 3.1796E+008$ , 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

#### Calculation of $\mu_{u1+}$

Calculation of ultimate curvature  $\mu_u$  according to 4.1, Biskinis/Fardis 2013:  
 $\mu_u = 0.00019144$   
 $\mu_u = 2.4327E+008$

with full section properties:

$b = 3000.00$   
 $d = 208.00$   
 $d' = 42.00$   
 $v = 0.00275581$   
 $N = 27514.027$   
 $f_c = 16.00$   
 $\alpha = (5A.5, TBDY) = 0.002$

Final value of  $cu$ :  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.0035$

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

From (5.4b), TBDY:  $cu = 0.0035$

we (5.4c) = 0.00

ase ((5.4d), TBDY) =  $(ase1 * A_{col1} + ase2 * A_{col2} + ase3 * A_{web}) / A_{sec} = 0.00$

ase1 = 0.00

sh\_1 = 100.00

bo\_1 = 190.00

ho\_1 = 540.00

bi2\_1 = 655400.00

ase2 = 0.00

sh\_2 = 100.00

bo\_2 = 190.00

ho\_2 = 540.00

bi2\_2 = 655400.00

ase3 = 0 (grid does not provide confinement)

psh,min =  $\text{Min}(psh,x, psh,y) = 0.0010472$

psh,x =  $ps1,x + ps2,x + ps3,x = 0.00439823$

ps1,x (column 1) =  $(As1 * h1 / s_1) / A_c = 0.00125664$

h1 = 600.00

As1 =  $A_{stir1} * ns1 = 157.0796$

No stirups, ns1 = 2.00

ps2,x (column 2) =  $(As2 * h2 / s_2) / A_c = 0.00125664$

h2 = 600.00

As2 =  $A_{stir2} * ns2 = 157.0796$

No stirups, ns2 = 2.00

ps3,x (web) =  $(As3 * h3 / s_3) / A_c = 0.00188496$

h3 = 1800.00

As3 =  $A_{stir3} * ns3 = 0.00$

No stirups, ns3 = 2.00

psh,y =  $ps1,y + ps2,y + ps3,y = 0.0010472$

ps1,y (column 1) =  $(As1 * h1 / s_1) / A_c = 0.0005236$

h1 = 250.00

As1 =  $A_{stir1} * ns1 = 157.0796$

No stirups, ns1 = 2.00

ps2,y (column 2) =  $(As2 * h2 / s_2) / A_c = 0.0005236$

h2 = 250.00

As2 =  $A_{stir2} * ns2 = 157.0796$

No stirups, ns2 = 2.00

ps3,y (web) =  $(As3 * h3 / s_3) / A_c = 0.00$

h3 = 250.00

As3 =  $A_{stir3} * ns3 = 157.0796$

No stirups, ns3 = 0.00

Asec = 750000.00

s\_1 = 100.00

s\_2 = 100.00

s\_3 = 200.00

fywe = 500.00

fce = 16.00

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

c = confinement factor = 1.00

y1 = 0.00208333

sh1 = 0.00805

ft1 = 600.00

fy1 = 500.00

su1 = 0.03226667

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

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

Shear\_factor = 1.00

lo/lou,min = lb/ld = 1.00

su1 =  $0.4 * esu1\_nominal$  ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,

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, ASCE41-17.  
 with  $fs1 = fs = 500.00$   
 with  $Es1 = Es = 200000.00$   
 $y2 = 0.00208333$   
 $sh2 = 0.00805$   
 $ft2 = 600.00$   
 $fy2 = 500.00$   
 $su2 = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $lo/lou, \min = lb/lb, \min = 1.00$   
 $su2 = 0.4 \cdot esu2_{\text{nominal}} ((5.5), \text{TBDY}) = 0.03226667$   
 From table 5A.1, TBDY:  $esu2_{\text{nominal}} = 0.08066667$ ,  
 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, ASCE41-17.  
 with  $fs2 = fs = 500.00$   
 with  $Es2 = Es = 200000.00$   
 $yv = 0.00208333$   
 $shv = 0.00805$   
 $ftv = 600.00$   
 $fyv = 500.00$   
 $suv = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $lo/lou, \min = lb/ld = 1.00$   
 $suv = 0.4 \cdot esuv_{\text{nominal}} ((5.5), \text{TBDY}) = 0.03226667$   
 From table 5A.1, TBDY:  $esuv_{\text{nominal}} = 0.08066667$ ,  
 considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{\text{nominal}}$  and  $yv, shv, ftv, fyv$ , it is considered  
 characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.  
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE41-17.  
 with  $fsv = fs = 500.00$   
 with  $Esv = Es = 200000.00$   
 $1 = Asl, \text{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.11862785$   
 $2 = Asl, \text{com} / (b \cdot d) \cdot (fs2 / fc) = 0.11862785$   
 $v = Asl, \text{mid} / (b \cdot d) \cdot (fsv / fc) = 0.00$   
 and confined core properties:  
 $b = 2940.00$   
 $d = 178.00$   
 $d' = 12.00$   
 $fcc (5A.2, \text{TBDY}) = 16.00$   
 $cc (5A.5, \text{TBDY}) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl, \text{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.14145031$   
 $2 = Asl, \text{com} / (b \cdot d) \cdot (fs2 / fc) = 0.14145031$   
 $v = Asl, \text{mid} / (b \cdot d) \cdot (fsv / fc) = 0.00$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' does not satisfy Eq. (4.3)  
 --->  
 $v < vs, c$  - RHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.18965884$   
 $Mu = MRc (4.14) = 2.4327E+008$   
 $u = su (4.1) = 0.00019144$

-----

Calculation of ratio  $lb/ld$

-----

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

-----

-----

Calculation of  $Mu1$ -

-----

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

$$\phi_u = 0.00019712$$

$$M_u = 3.1796 \times 10^8$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$\nu = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.0035$$

$$\omega_e \text{ (5.4c)} = 0.00$$

$$\omega_{ase} \text{ ((5.4d), TBDY)} = (\omega_{ase1} * A_{col1} + \omega_{ase2} * A_{col2} + \omega_{ase3} * A_{web}) / A_{sec} = 0.00$$

$$\omega_{ase1} = 0.00$$

$$sh_1 = 100.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$\omega_{ase2} = 0.00$$

$$sh_2 = 100.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$\omega_{ase3} = 0 \text{ (grid does not provide confinement)}$$

$$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.0010472$$

$$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00439823$$

$$\phi_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00125664$$

$$h_1 = 600.00$$

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

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

$$\phi_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00125664$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\phi_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirups, } n_{s3} = 2.00$$

$$\phi_{sh,y} = \phi_{s1,y} + \phi_{s2,y} + \phi_{s3,y} = 0.0010472$$

$$\phi_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.0005236$$

$$h_1 = 250.00$$

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

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

$$\phi_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.0005236$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\phi_{s3,y} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

$$\text{No stirups, } n_{s3} = 0.00$$

$$A_{sec} = 750000.00$$

$$s_1 = 100.00$$

$$s_2 = 100.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 500.00$$

$$f_{ce} = 16.00$$

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

```

c = confinement factor = 1.00
y1 = 0.00208333
sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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, ASCE41-17.
with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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, ASCE41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785
2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785
v = Asl,mid/(b*d)*(fsv/fc) = 0.08055366
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031
2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031
v = Asl,mid/(b*d)*(fsv/fc) = 0.09605114
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied

```

--->

$$su(4.9) = 0.2130262$$

$$\mu = MRc(4.14) = 3.1796E+008$$

$$u = su(4.1) = 0.00019712$$

Calculation of ratio  $l_b/l_d$

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

Calculation of  $\mu_{2+}$

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

$$u = 0.00019144$$

$$\mu = 2.4327E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear\_factor} * \text{Max}(c_u, c_c) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } c_u = 0.0035$$

$$w_e(5.4c) = 0.00$$

$$a_{se}((5.4d), TBDY) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 100.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 100.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$psh, \min = \text{Min}(psh, x, psh, y) = 0.0010472$$

$$psh, x = ps1, x + ps2, x + ps3, x = 0.00439823$$

$$ps1, x \text{ (column 1)} = (As1 * h1 / s_1) / A_c = 0.00125664$$

$$h1 = 600.00$$

$$As1 = Astir1 * ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2, x \text{ (column 2)} = (As2 * h2 / s_2) / A_c = 0.00125664$$

$$h2 = 600.00$$

$$As2 = Astir2 * ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3, x \text{ (web)} = (As3 * h3 / s_3) / A_c = 0.00188496$$

$$h3 = 1800.00$$

$$As3 = Astir3 * ns3 = 0.00$$

$$\text{No stirups, } ns3 = 2.00$$

$$psh, y = ps1, y + ps2, y + ps3, y = 0.0010472$$

$$ps1, y \text{ (column 1)} = (As1 * h1 / s_1) / A_c = 0.0005236$$

$$h1 = 250.00$$

$$As1 = Astir1 * ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2, y \text{ (column 2)} = (As2 * h2 / s_2) / A_c = 0.0005236$$

$$h2 = 250.00$$



$As2 = Astir2 * ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,y (web) = (As3 * h3 / s_3) / Ac = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 * ns3 = 157.0796$   
 No stirups,  $ns3 = 0.00$

-----

$Asec = 750000.00$

$s_1 = 100.00$

$s_2 = 100.00$

$s_3 = 200.00$

$fywe = 500.00$

$fce = 16.00$

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

$c =$  confinement factor  $= 1.00$

$y1 = 0.00208333$

$sh1 = 0.00805$

$ft1 = 600.00$

$fy1 = 500.00$

$su1 = 0.03226667$

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

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

$su1 = 0.4 * esu1\_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fs1 = fs = 500.00$

with  $Es1 = Es = 200000.00$

$y2 = 0.00208333$

$sh2 = 0.00805$

$ft2 = 600.00$

$fy2 = 500.00$

$su2 = 0.03226667$

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

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

$su2 = 0.4 * esu2\_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fs2 = fs = 500.00$

with  $Es2 = Es = 200000.00$

$yv = 0.00208333$

$shv = 0.00805$

$ftv = 600.00$

$fyv = 500.00$

$suv = 0.03226667$

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

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

$suv = 0.4 * esuv\_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY:  $esuv\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fsv = fs = 500.00$

with  $Esv = Es = 200000.00$

$1 = Asl,ten / (b * d) * (fs1 / fc) = 0.11862785$

$2 = Asl,com / (b * d) * (fs2 / fc) = 0.11862785$

$v = Asl,mid / (b * d) * (fsv / fc) = 0.00$

and confined core properties:

$$b = 2940.00$$

$$d = 178.00$$

$$d' = 12.00$$

$$fcc(5A.2, TBDY) = 16.00$$

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

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

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.14145031$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.14145031$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.00$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

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

--->

$$s_u(4.9) = 0.18965884$$

$$M_u = M_{Rc}(4.14) = 2.4327E+008$$

$$u = s_u(4.1) = 0.00019144$$

Calculation of ratio  $I_b/I_d$

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

Calculation of  $M_{u2}$ -

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

$$u = 0.00019712$$

$$M_u = 3.1796E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.0035$$

$$\phi_{we}(5.4c) = 0.00$$

$$a_{se}((5.4d), TBDY) = (a_{se1}*A_{col1} + a_{se2}*A_{col2} + a_{se3}*A_{web})/A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 100.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 100.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.0010472$$

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00439823$$

$$p_{s1,x}(\text{column 1}) = (A_{s1}*h_1/s_1)/A_c = 0.00125664$$

$$h_1 = 600.00$$

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

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

$$p_{s2,x}(\text{column 2}) = (A_{s2}*h_2/s_2)/A_c = 0.00125664$$

$$h_2 = 600.00$$

$As2 = Astir2 * ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,x \text{ (web)} = (As3 * h3 / s_3) / Ac = 0.00188496$   
 $h3 = 1800.00$   
 $As3 = Astir3 * ns3 = 0.00$   
 No stirups,  $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.0010472$   
 $ps1,y \text{ (column 1)} = (As1 * h1 / s_1) / Ac = 0.0005236$   
 $h1 = 250.00$   
 $As1 = Astir1 * ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,y \text{ (column 2)} = (As2 * h2 / s_2) / Ac = 0.0005236$   
 $h2 = 250.00$   
 $As2 = Astir2 * ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,y \text{ (web)} = (As3 * h3 / s_3) / Ac = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 * ns3 = 157.0796$   
 No stirups,  $ns3 = 0.00$

$Asec = 750000.00$   
 $s_1 = 100.00$   
 $s_2 = 100.00$   
 $s_3 = 200.00$   
 $fywe = 500.00$   
 $fce = 16.00$   
 From ((5.A5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $y1 = 0.00208333$   
 $sh1 = 0.00805$   
 $ft1 = 600.00$   
 $fy1 = 500.00$   
 $su1 = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $Shear\_factor = 1.00$   
 $lo/lou,min = lb/l_d = 1.00$   
 $su1 = 0.4 * esu1\_nominal \text{ ((5.5), TBDY)} = 0.03226667$   
 From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,  
 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, ASCE41-17.  
 with  $fs1 = fs = 500.00$   
 with  $Es1 = Es = 200000.00$   
 $y2 = 0.00208333$   
 $sh2 = 0.00805$   
 $ft2 = 600.00$   
 $fy2 = 500.00$   
 $su2 = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $Shear\_factor = 1.00$   
 $lo/lou,min = lb/l_b,min = 1.00$   
 $su2 = 0.4 * esu2\_nominal \text{ ((5.5), TBDY)} = 0.03226667$   
 From table 5A.1, TBDY:  $esu2\_nominal = 0.08066667$ ,  
 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, ASCE41-17.  
 with  $fs2 = fs = 500.00$   
 with  $Es2 = Es = 200000.00$   
 $yv = 0.00208333$   
 $shv = 0.00805$   
 $ftv = 600.00$   
 $fyv = 500.00$   
 $suv = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor

and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.03226667$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08066667$ ,  
 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, ASCE41-17.  
 with  $fsv = fs = 500.00$   
 with  $Esv = Es = 200000.00$   
 $1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.11862785$   
 $2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.11862785$   
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.08055366$   
 and confined core properties:  
 $b = 2940.00$   
 $d = 178.00$   
 $d' = 12.00$   
 $f_{cc} (5A.2, TBDY) = 16.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.14145031$   
 $2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.14145031$   
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.09605114$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' does not satisfy Eq. (4.3)  
 --->  
 $v < v_{s,c}$  - RHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.2130262$   
 $Mu = MRc (4.14) = 3.1796E+008$   
 $u = su (4.1) = 0.00019712$

Calculation of ratio  $l_b/l_d$

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

Calculation of Shear Strength  $V_r = Min(V_{r1}, V_{r2}) = 904830.218$

Calculation of Shear Strength at edge 1,  $V_{r1} = 904830.218$   
 From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r1} = V_n < 0.83 * f_c'^{0.5} * h * d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$   
 $Mu/V_u - l_w/2 = 0.00 \leq 0$   
 $= 1$  (normal-weight concrete)  
 $f_c' = 16.00$ , but  $f_c'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $h = 3000.00$   
 $d = 200.00$   
 $l_w = 250.00$   
 $Mu = 2.0446822E-012$   
 $V_u = 2.0366709E-032$   
 $Nu = 27514.027$   
 From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 251327.412$   
 $V_{s1} = 125663.706$  is calculated for pseudo-Column 1, with:  
 $d = 200.00$   
 $Av = 157079.633$   
 $s = 100.00$   
 $fy = 400.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17, 10.3.4)  
 $V_{s2} = 125663.706$  is calculated for pseudo-Column 2, with:

d = 200.00

Av = 157079.633

s = 100.00

fy = 400.00

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

Vs3 = 0.00 is calculated for web, with:

d = 200.00

Av = 0.00

s = 200.00

fy = 400.00

Vs3 has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

bw = 3000.00

Calculation of Shear Strength at edge 2, Vr2 = 904830.218

From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_r2 = V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14: Vc = 653502.805

$\mu_u/V_u - l_w/2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$ , but  $f_c' \cdot 0.5 \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

h = 3000.00

d = 200.00

lw = 250.00

$\mu_u = 2.0446822E-012$

$V_u = 2.0366709E-032$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 251327.412$

Vs1 = 125663.706 is calculated for pseudo-Column 1, with:

d = 200.00

Av = 157079.633

s = 100.00

fy = 400.00

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

Vs2 = 125663.706 is calculated for pseudo-Column 2, with:

d = 200.00

Av = 157079.633

s = 100.00

fy = 400.00

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

Vs3 = 0.00 is calculated for web, with:

d = 200.00

Av = 0.00

s = 200.00

fy = 400.00

Vs3 has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

bw = 3000.00

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcrcws

## Constant Properties

Knowledge Factor,  $\phi = 1.00$

According to 10.7.2.3, ASCE 41-17, shear walls with transverse reinforcement percentage,  $\rho_n < 0.0015$

are considered Force-Controlled and lower-bound strengths are used according to 7.5.1.3, ASCE 41-17  
 $\rho_n = 0.0010472$

with  $\rho_n = \rho_{s1} + \rho_{s2} + \rho_{s3}$ , being the shear reinf. ratio in a plane perpendicular to the shear axis 3

(pseudo-col.1  $\rho_{s1} = A_{s1} \cdot b_1 / s_1 = (A_{s1} \cdot h_1 / s_1) / A_c = 0.0005236$

$h_1 = 250.00$

$s_1 = 100.00$

total area of hoops perpendicular to shear axis,  $A_{s1} = 157.0796$

(pseudo-col.2  $\rho_{s2} = A_{s2} \cdot b_2 / s_2 = (A_{s2} \cdot h_2 / s_2) / A_c = 0.0005236$

$h_2 = 250.00$

$s_2 = 100.00$

total area of hoops perpendicular to shear axis,  $A_{s2} = 157.0796$

(grid  $\rho_{s3} = A_{s3} \cdot b_3 / s_3 = (A_{s3} \cdot h_3 / s_3) / A_c = 0.00$

$h_3 = 250.00$

$s_3 = 200.00$

total area of hoops perpendicular to shear axis,  $A_{s3} = 0.00$

total section area,  $A_c = 750000.00$

Consequently:

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,  $E_s = 200000.00$

Total Height,  $H_{tot} = 3000.00$

Edges Width,  $W_{edg} = 250.00$

Edges Height,  $H_{edg} = 600.00$

Web Width,  $W_{web} = 250.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

## Stepwise Properties

Axial Force,  $F = -27619.81$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $A_{st} = 0.00$

-Compression:  $A_{sc} = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $A_{st,ten} = 2865.133$

-Compression:  $A_{st,com} = 2865.133$

-Middle:  $A_{st,mid} = 615.7522$

Mean Diameter of Tension Reinforcement,  $D_bL = 17.33333$

Considering wall controlled by Shear (shear control ratio  $> 1$ ),

interstorey drift provided values are calculated

Existing component: From table 7-7, ASCE 41\_17: Final interstorey drift Capacity  $u_{i,R} = \phi \cdot u = 0.015$

from table 10-20:  $u = 0.015$

with:

- Condition i (shear wall and wall segments)

-  $(A_s - A_s') \cdot f_y + P / (t_w \cdot l_w \cdot f_c') = -0.20923225$

$A_s = 0.00$

$A_s' = 6346.017$

$f_y = 400.00$   
 $P = 27619.81$   
 $t_w = 250.00$   
 $I_w = 3000.00$   
 $f_c = 16.00$

-----  
End Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1  
At local axis: 2  
Integration Section: (a)  
-----

## Calculation No. 11

wall W1, Floor 1  
Limit State: Life Safety (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: wall W1 of floor 1  
At local axis: 3  
Integration Section: (a)  
Section Type: rcwrs

Constant Properties

-----  
Knowledge Factor,  $\gamma = 1.00$   
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.  
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17  
Consequently:  
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,  $E_s = 200000.00$

Total Height, Htot = 3000.00  
 Edges Width, Wedg = 250.00  
 Edges Height, Hedg = 600.00  
 Web Width, Wweb = 250.00  
 Cover Thickness, c = 25.00  
 Element Length, L = 3000.00  
 Primary Member  
 Ribbed Bars  
 Ductile Steel  
 With Detailing for Earthquake Resistance (including stirrups closed at 135°)  
 Longitudinal Bars With Ends Lapped Starting at the End Sections  
 Adequate Lap Length ( $l_o/l_{o,u,min} = l_b/l_d \geq 1$ )  
 No FRP Wrapping

#### Stepwise Properties

EDGE -A-  
 Bending Moment, Ma = 9.5039E+007  
 Shear Force, Va = -31682.313  
 EDGE -B-  
 Bending Moment, Mb = 17822.236  
 Shear Force, Vb = 31682.313  
 BOTH EDGES  
 Axial Force, F = -27619.81  
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
 -Tension: Aslt = 0.00  
 -Compression: Aslc = 6346.017  
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
 -Tension: Asl,ten = 2865.133  
 -Compression: Asl,com = 2865.133  
 -Middle: Asl,mid = 615.7522  
 Mean Diameter of Tension Reinforcement, DbL,ten = 17.33333

Existing component: From table 7-7, ASCE 41\_17: Final Shear Capacity VR =  $V_n = 1.6645E+006$   
 From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d = 1.6645E+006$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 608920.436$   
 $M_u/V_u - l_w/2 = 1499.748 > 0$   
 = 1 (normal-weight concrete)  
 $f_c' = 16.00$ , but  $f_c' \cdot 0.5 \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $h = 250.00$   
 $d = 2400.00$   
 $l_w = 3000.00$   
 $M_u = 9.5039E+007$   
 $V_u = 31682.313$   
 $N_u = 27619.81$   
 From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0556E+006$   
 $V_{s1} = 301592.895$  is calculated for pseudo-Column 1, with:  
 $d = 480.00$   
 $A_v = 157079.633$   
 $s = 100.00$   
 $f_y = 400.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 301592.895$  is calculated for pseudo-Column 2, with:  
 $d = 480.00$   
 $A_v = 157079.633$   
 $s = 100.00$   
 $f_y = 400.00$   
 $V_{s2}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s3} = 452389.342$  is calculated for web, with:



$d = 1440.00$   
 $A_v = 157079.633$   
 $s = 200.00$   
 $f_y = 400.00$   
 Vs3 has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$   
 From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$   
 $b_w = 250.00$

-----  
 End Of Calculation of Shear Capacity for element: wall W1 of floor 1  
 At local axis: 3  
 Integration Section: (a)  
 -----

## Calculation No. 12

wall W1, Floor 1  
 Limit State: Life Safety (data interpolation between analysis steps 1 and 2)  
 Analysis: Uniform +X  
 Check: Chord rotation capacity (  $\phi$  )  
 Edge: Start  
 Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1  
 At Shear local axis: 3  
 (Bending local axis: 2)  
 Section Type: rcwrs

Constant Properties

-----  
 Knowledge Factor,  $\phi = 1.00$   
 Mean strength values are used for both shear and moment calculations.  
 Consequently:  
 Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 16.00$   
 Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 400.00$   
 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

Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 500.00$

#####

Total Height,  $H_{tot} = 3000.00$

Edges Width,  $W_{edg} = 250.00$

Edges Height,  $H_{edg} = 600.00$

Web Width,  $W_{web} = 250.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

-----

Stepwise Properties

-----

At local axis: 3

EDGE -A-

Shear Force,  $V_a = -3.6423187E-030$

EDGE -B-

Shear Force,  $V_b = 3.6423187E-030$

BOTH EDGES

Axial Force,  $F = -27514.027$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $As_t = 0.00$

-Compression:  $As_c = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{t,ten} = 2865.133$

-Compression:  $As_{l,com} = 2865.133$

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

(According to 10.7.2.3  $As_{l,mid}$  is setted equal to zero)

-----

-----

Calculation of Shear Capacity ratio ,  $V_e/V_r = 2.25608$

Member Controlled by Shear ( $V_e/V_r > 1$ )

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n = 3.8558E+006$

with

$M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 5.7837E+009$

$\mu_{u1+} = 5.0210E+009$ , 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

$\mu_{u1-} = 5.7837E+009$ , 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

$M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 5.7837E+009$

$\mu_{u2+} = 5.0210E+009$ , 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

$\mu_{u2-} = 5.7837E+009$ , 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

-----

Calculation of  $\mu_{u1+}$

-----

-----

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

$\mu_u = 1.1673539E-005$

$\mu_u = 5.0210E+009$

-----

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$   
 $v = 0.00232618$   
 $N = 27514.027$   
 $f_c = 16.00$   
 $\phi (5A.5, TBDY) = 0.002$   
 Final value of  $\phi$ :  $\phi^* = \text{shear\_factor} * \text{Max}(\phi, \phi_c) = 0.0035$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $\phi = 0.0035$   
 $\phi (5.4c) = 0.00$   
 $\phi ((5.4d), TBDY) = (\phi_1 * A_{col1} + \phi_2 * A_{col2} + \phi_3 * A_{web}) / A_{sec} = 0.00$   
 $\phi_1 = 0.00$   
 $s_1 = 100.00$   
 $b_1 = 190.00$   
 $h_1 = 540.00$   
 $b_{12} = 655400.00$   
 $\phi_2 = 0.00$   
 $s_2 = 100.00$   
 $b_2 = 190.00$   
 $h_2 = 540.00$   
 $b_{12} = 655400.00$   
 $\phi_3 = 0$  (grid does not provide confinement)  
 $\phi_{min} = \text{Min}(\phi_x, \phi_y) = 0.0010472$

$\phi_x = \phi_{1,x} + \phi_{2,x} + \phi_{3,x} = 0.00439823$   
 $\phi_{1,x} (\text{column 1}) = (A_1 * h_1 / s_1) / A_c = 0.00125664$   
 $h_1 = 600.00$   
 $A_1 = A_{stir1} * n_{s1} = 157.0796$   
 No stirups,  $n_{s1} = 2.00$   
 $\phi_{2,x} (\text{column 2}) = (A_2 * h_2 / s_2) / A_c = 0.00125664$   
 $h_2 = 600.00$   
 $A_2 = A_{stir2} * n_{s2} = 157.0796$   
 No stirups,  $n_{s2} = 2.00$   
 $\phi_{3,x} (\text{web}) = (A_3 * h_3 / s_3) / A_c = 0.00188496$   
 $h_3 = 1800.00$   
 $A_3 = A_{stir3} * n_{s3} = 0.00$   
 No stirups,  $n_{s3} = 2.00$

$\phi_y = \phi_{1,y} + \phi_{2,y} + \phi_{3,y} = 0.0010472$   
 $\phi_{1,y} (\text{column 1}) = (A_1 * h_1 / s_1) / A_c = 0.0005236$   
 $h_1 = 250.00$   
 $A_1 = A_{stir1} * n_{s1} = 157.0796$   
 No stirups,  $n_{s1} = 2.00$   
 $\phi_{2,y} (\text{column 2}) = (A_2 * h_2 / s_2) / A_c = 0.0005236$   
 $h_2 = 250.00$   
 $A_2 = A_{stir2} * n_{s2} = 157.0796$   
 No stirups,  $n_{s2} = 2.00$   
 $\phi_{3,y} (\text{web}) = (A_3 * h_3 / s_3) / A_c = 0.00$   
 $h_3 = 250.00$   
 $A_3 = A_{stir3} * n_{s3} = 157.0796$   
 No stirups,  $n_{s3} = 0.00$

$A_{sec} = 750000.00$   
 $s_1 = 100.00$   
 $s_2 = 100.00$   
 $s_3 = 200.00$

$f_{ywe} = 500.00$   
 $f_{ce} = 16.00$

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

$y_1 = 0.00208333$   
 $s_1 = 0.00805$   
 $f_{t1} = 600.00$   
 $f_{y1} = 500.00$   
 $s_u1 = 0.03226667$

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

```

lo/lou,min = lb/d = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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, ASCE41-17.
with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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, ASCE41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652
2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723
2 = Asl,com/(b*d)*(fs2/fc) = 0.16099723
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
---->
v < vs,y2 - LHS eq.(4.5) is satisfied
---->
su (4.9) = 0.06523978
Mu = MRc (4.14) = 5.0210E+009
u = su (4.1) = 1.1673539E-005

```

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

## Calculation of Mu1-

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

$$\mu = 1.1958028E-005$$

$$Mu = 5.7837E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear\_factor} * \text{Max}(\mu, cc) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \mu = 0.0035$$

$$w_e \text{ (5.4c)} = 0.00$$

$$ase \text{ ((5.4d), TBDY)} = (ase1 * A_{col1} + ase2 * A_{col2} + ase3 * A_{web}) / A_{sec} = 0.00$$

$$ase1 = 0.00$$

$$sh_1 = 100.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$ase2 = 0.00$$

$$sh_2 = 100.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$ase3 = 0 \text{ (grid does not provide confinement)}$$

$$psh_{min} = \text{Min}(psh_x, psh_y) = 0.0010472$$

$$psh_x = ps1_x + ps2_x + ps3_x = 0.00439823$$

$$ps1_x \text{ (column 1)} = (As1 * h1 / s_1) / A_c = 0.00125664$$

$$h1 = 600.00$$

$$As1 = Astir1 * ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2_x \text{ (column 2)} = (As2 * h2 / s_2) / A_c = 0.00125664$$

$$h2 = 600.00$$

$$As2 = Astir2 * ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3_x \text{ (web)} = (As3 * h3 / s_3) / A_c = 0.00188496$$

$$h3 = 1800.00$$

$$As3 = Astir3 * ns3 = 0.00$$

$$\text{No stirups, } ns3 = 2.00$$

$$psh_y = ps1_y + ps2_y + ps3_y = 0.0010472$$

$$ps1_y \text{ (column 1)} = (As1 * h1 / s_1) / A_c = 0.0005236$$

$$h1 = 250.00$$

$$As1 = Astir1 * ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2_y \text{ (column 2)} = (As2 * h2 / s_2) / A_c = 0.0005236$$

$$h2 = 250.00$$

$$As2 = Astir2 * ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3_y \text{ (web)} = (As3 * h3 / s_3) / A_c = 0.00$$

$$h3 = 250.00$$

$$As3 = Astir3 * ns3 = 157.0796$$

$$\text{No stirups, } ns3 = 0.00$$

$$A_{sec} = 750000.00$$

$$s_1 = 100.00$$

```

s_2 = 100.00
s_3 = 200.00
fywe = 500.00
fce = 16.00
From ((5A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00208333
sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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, ASCE41-17.
with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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, ASCE41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652
2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652
v = Asl,mid/(b*d)*(fsv/fc) = 0.02602943
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723
2 = Asl,com/(b*d)*(fs2/fc) = 0.16099723

```

$v = A_{sl, mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.03460028$   
Case/Assumption: Unconfined full section - Steel rupture  
satisfies Eq. (4.3)

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

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

--->  
 $s_u(4.8) = 0.08747825$   
 $\mu_u = M_{Rc}(4.15) = 5.7837E+009$   
 $u = s_u(4.1) = 1.1958028E-005$

Calculation of ratio  $I_b/I_d$

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

Calculation of  $\mu_{u2+}$

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

$u = 1.1673539E-005$   
 $\mu_u = 5.0210E+009$

with full section properties:

$b = 250.00$   
 $d = 2957.00$   
 $d' = 43.00$   
 $v = 0.00232618$   
 $N = 27514.027$

$f_c = 16.00$   
 $\alpha(5A.5, TBDY) = 0.002$

Final value of  $\alpha_u$ :  $\alpha_u = \text{shear\_factor} \cdot \text{Max}(\alpha_u, \alpha_c) = 0.0035$

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

From (5.4b), TBDY:  $\alpha_u = 0.0035$

$\alpha_{we}(5.4c) = 0.00$

$\alpha_{ase}((5.4d), TBDY) = (\alpha_{ase1} \cdot A_{col1} + \alpha_{ase2} \cdot A_{col2} + \alpha_{ase3} \cdot A_{web}) / A_{sec} = 0.00$

$\alpha_{ase1} = 0.00$

$sh_1 = 100.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$\alpha_{ase2} = 0.00$

$sh_2 = 100.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$\alpha_{ase3} = 0$  (grid does not provide confinement)

$p_{sh, min} = \text{Min}(p_{sh, x}, p_{sh, y}) = 0.0010472$

$p_{sh, x} = p_{s1, x} + p_{s2, x} + p_{s3, x} = 0.00439823$

$p_{s1, x}(\text{column 1}) = (A_{s1} \cdot h_1 / s_1) / A_c = 0.00125664$

$h_1 = 600.00$

$A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$

No stirups,  $n_{s1} = 2.00$

$p_{s2, x}(\text{column 2}) = (A_{s2} \cdot h_2 / s_2) / A_c = 0.00125664$

$h_2 = 600.00$

$A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$

No stirups,  $n_{s2} = 2.00$

$p_{s3, x}(\text{web}) = (A_{s3} \cdot h_3 / s_3) / A_c = 0.00188496$

$h_3 = 1800.00$

$A_{s3} = A_{stir3} \cdot n_{s3} = 0.00$

No stirups,  $n_{s3} = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.0010472$   
 $ps1,y \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.0005236$   
 $h1 = 250.00$   
 $As1 = Astir1 \cdot ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.0005236$   
 $h2 = 250.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,y \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 \cdot ns3 = 157.0796$   
 No stirups,  $ns3 = 0.00$

-----  
 $Asec = 750000.00$

$s_1 = 100.00$

$s_2 = 100.00$

$s_3 = 200.00$

$fywe = 500.00$

$fce = 16.00$

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

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

$y1 = 0.00208333$

$sh1 = 0.00805$

$ft1 = 600.00$

$fy1 = 500.00$

$su1 = 0.03226667$

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

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

$su1 = 0.4 \cdot esu1\_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fs1 = fs = 500.00$

with  $Es1 = Es = 200000.00$

$y2 = 0.00208333$

$sh2 = 0.00805$

$ft2 = 600.00$

$fy2 = 500.00$

$su2 = 0.03226667$

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

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

$su2 = 0.4 \cdot esu2\_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fs2 = fs = 500.00$

with  $Es2 = Es = 200000.00$

$yv = 0.00208333$

$shv = 0.00805$

$ftv = 600.00$

$fyv = 500.00$

$suv = 0.03226667$

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

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

$suv = 0.4 \cdot esuv\_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY:  $esuv\_nominal = 0.08066667$ ,

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



characteristic value  $f_{sv} = f_{sv}/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE41-17.  
 with  $f_{sv} = f_s = 500.00$   
 with  $E_{sv} = E_s = 200000.00$   
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.12111652$   
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.12111652$   
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$   
 and confined core properties:  
 $b = 190.00$   
 $d = 2927.00$   
 $d' = 13.00$   
 $f_{cc} \text{ (5A.2, TBDY)} = 16.00$   
 $cc \text{ (5A.5, TBDY)} = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.16099723$   
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.16099723$   
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is satisfied  
 --->  
 $su \text{ (4.9)} = 0.06523978$   
 $Mu = MR_c \text{ (4.14)} = 5.0210E+009$   
 $u = su \text{ (4.1)} = 1.1673539E-005$

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

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

Calculation of  $Mu_2$ -  
 -----  
 -----

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

$u = 1.1958028E-005$   
 $Mu = 5.7837E+009$   
 -----

with full section properties:

$b = 250.00$   
 $d = 2957.00$   
 $d' = 43.00$   
 $v = 0.00232618$   
 $N = 27514.027$   
 $f_c = 16.00$   
 $co \text{ (5A.5, TBDY)} = 0.002$   
 Final value of  $cu$ :  $cu^* = \text{shear\_factor} \cdot \text{Max}(cu, cc) = 0.0035$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.0035$   
 $w_e \text{ (5.4c)} = 0.00$   
 $ase \text{ ((5.4d), TBDY)} = (ase1 \cdot A_{col1} + ase2 \cdot A_{col2} + ase3 \cdot A_{web})/A_{sec} = 0.00$   
 $ase1 = 0.00$   
 $sh_1 = 100.00$   
 $bo_1 = 190.00$   
 $ho_1 = 540.00$   
 $bi2_1 = 655400.00$   
 $ase2 = 0.00$   
 $sh_2 = 100.00$   
 $bo_2 = 190.00$   
 $ho_2 = 540.00$   
 $bi2_2 = 655400.00$   
 $ase3 = 0$  (grid does not provide confinement)  
 $psh_{min} = \text{Min}(psh_x, psh_y) = 0.0010472$   
 -----

$psh,x = ps1,x + ps2,x + ps3,x = 0.00439823$   
 $ps1,x \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00125664$   
 $h1 = 600.00$   
 $As1 = Astir1 \cdot ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,x \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00125664$   
 $h2 = 600.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,x \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00188496$   
 $h3 = 1800.00$   
 $As3 = Astir3 \cdot ns3 = 0.00$   
 No stirups,  $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.0010472$   
 $ps1,y \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.0005236$   
 $h1 = 250.00$   
 $As1 = Astir1 \cdot ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.0005236$   
 $h2 = 250.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,y \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 \cdot ns3 = 157.0796$   
 No stirups,  $ns3 = 0.00$

$Asec = 750000.00$   
 $s_1 = 100.00$   
 $s_2 = 100.00$   
 $s_3 = 200.00$   
 $fywe = 500.00$   
 $fce = 16.00$

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

$y1 = 0.00208333$

$sh1 = 0.00805$

$ft1 = 600.00$

$fy1 = 500.00$

$su1 = 0.03226667$

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

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

$su1 = 0.4 \cdot esu1\_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fs1 = fs = 500.00$

with  $Es1 = Es = 200000.00$

$y2 = 0.00208333$

$sh2 = 0.00805$

$ft2 = 600.00$

$fy2 = 500.00$

$su2 = 0.03226667$

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

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

$su2 = 0.4 \cdot esu2\_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fs2 = fs = 500.00$

```

with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652
2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652
v = Asl,mid/(b*d)*(fsv/fc) = 0.02602943
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723
2 = Asl,com/(b*d)*(fs2/fc) = 0.16099723
v = Asl,mid/(b*d)*(fsv/fc) = 0.03460028
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.8) = 0.08747825
Mu = MRc (4.15) = 5.7837E+009
u = su (4.1) = 1.1958028E-005

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength  $V_r = \min(V_{r1}, V_{r2}) = 1.7091E+006$

Calculation of Shear Strength at edge 1,  $V_{r1} = 1.7091E+006$   
From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r1} = V_n < 0.83*fc'^{0.5}*h*d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$   
 $M_u/V_u - l_w/2 = 0.00 \leq 0$   
= 1 (normal-weight concrete)  
 $fc' = 16.00$ , but  $fc'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
h = 250.00  
d = 2400.00  
lw = 3000.00  
 $M_u = 2.8146476E-010$   
 $V_u = 3.6423187E-030$

Nu = 27514.027

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0556E+006$

$V_{s1} = 301592.895$  is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s2} = 301592.895$  is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s3} = 452389.342$  is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 400.00$

$V_{s3}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

$b_w = 250.00$

Calculation of Shear Strength at edge 2,  $V_{r2} = 1.7091E+006$

From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r2} = V_n < 0.83 \cdot f_c'^{0.5} \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$

$\mu_u / V_u - l_w / 2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$ , but  $f_c'^{0.5} \leq 8.3 \text{ MPa}$  (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 2.8146476E-010$

$V_u = 3.6423187E-030$

Nu = 27514.027

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0556E+006$

$V_{s1} = 301592.895$  is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s2} = 301592.895$  is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s3} = 452389.342$  is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 400.00$

$V_{s3}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

$b_w = 250.00$

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcrcws

#### Constant Properties

Knowledge Factor,  $\gamma = 1.00$

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

Consequently:

Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 16.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 400.00$

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

Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 500.00$

#####

Total Height,  $H_{tot} = 3000.00$

Edges Width,  $W_{edg} = 250.00$

Edges Height,  $H_{edg} = 600.00$

Web Width,  $W_{web} = 250.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

#### Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force,  $V_a = -2.0366709E-032$

EDGE -B-

Shear Force,  $V_b = 2.0366709E-032$

BOTH EDGES

Axial Force,  $F = -27514.027$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $A_{sl,t} = 0.00$

-Compression:  $A_{sl,c} = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $A_{sl,ten} = 2368.761$

-Compression:  $A_{sl,com} = 2368.761$

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

(According to 10.7.2.3  $A_{sl,mid}$  is setted equal to zero)

Calculation of Shear Capacity ratio,  $V_e/V_r = 0.23426757$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n = 211972.373$

with

$M_{pr1} = \max(M_{u1+}, M_{u1-}) = 3.1796E+008$

$M_{u1+} = 2.4327E+008$ , 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

$M_{u1-} = 3.1796E+008$ , 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

$$M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 3.1796E+008$$

$Mu_{2+} = 2.4327E+008$ , 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

$Mu_{2-} = 3.1796E+008$ , 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

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

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

$$\phi_u = 0.00019144$$

$$Mu = 2.4327E+008$$

-----  
with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear\_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.0035$$

$$\phi_{we} (5.4c) = 0.00$$

$$\phi_{ase} ((5.4d), \text{TBDY}) = (\phi_{ase1} * A_{col1} + \phi_{ase2} * A_{col2} + \phi_{ase3} * A_{web}) / A_{sec} = 0.00$$

$$\phi_{ase1} = 0.00$$

$$sh\_1 = 100.00$$

$$bo\_1 = 190.00$$

$$ho\_1 = 540.00$$

$$bi2\_1 = 655400.00$$

$$\phi_{ase2} = 0.00$$

$$sh\_2 = 100.00$$

$$bo\_2 = 190.00$$

$$ho\_2 = 540.00$$

$$bi2\_2 = 655400.00$$

$$\phi_{ase3} = 0 \text{ (grid does not provide confinement)}$$

$$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.0010472$$

-----  
 $\phi_{psh,x} = \phi_{ps1,x} + \phi_{ps2,x} + \phi_{ps3,x} = 0.00439823$

$$\phi_{ps1,x} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00125664$$

$$h_1 = 600.00$$

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

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

$$\phi_{ps2,x} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00125664$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\phi_{ps3,x} (\text{web}) = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirups, } n_{s3} = 2.00$$

-----  
 $\phi_{psh,y} = \phi_{ps1,y} + \phi_{ps2,y} + \phi_{ps3,y} = 0.0010472$

$$\phi_{ps1,y} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.0005236$$

$$h_1 = 250.00$$

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

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

$$\phi_{ps2,y} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.0005236$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\phi_{ps3,y} (\text{web}) = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

No stirrups, ns3 = 0.00

Asec = 750000.00

s\_1 = 100.00

s\_2 = 100.00

s\_3 = 200.00

fywe = 500.00

fce = 16.00

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

c = confinement factor = 1.00

y1 = 0.00208333

sh1 = 0.00805

ft1 = 600.00

fy1 = 500.00

su1 = 0.03226667

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

lo/lou,min = lb/lb = 1.00

su1 = 0.4\*esu1\_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1\_nominal = 0.08066667,

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, ASCE41-17.

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

y2 = 0.00208333

sh2 = 0.00805

ft2 = 600.00

fy2 = 500.00

su2 = 0.03226667

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

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

su2 = 0.4\*esu2\_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2\_nominal = 0.08066667,

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, ASCE41-17.

with fs2 = fs = 500.00

with Es2 = Es = 200000.00

yv = 0.00208333

shv = 0.00805

ftv = 600.00

fyv = 500.00

suv = 0.03226667

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

lo/lou,min = lb/lb = 1.00

suv = 0.4\*esuv\_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esuv\_nominal = 0.08066667,

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, ASCE41-17.

with fsv = fs = 500.00

with Esv = Es = 200000.00

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.11862785

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.11862785

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.00

and confined core properties:

b = 2940.00

d = 178.00

d' = 12.00

fcc (5A.2, TBDY) = 16.00

```

cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031
2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18965884
Mu = MRc (4.14) = 2.4327E+008
u = su (4.1) = 0.00019144

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

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

```

u = 0.00019712
Mu = 3.1796E+008

```

with full section properties:

```

b = 3000.00
d = 208.00
d' = 42.00
v = 0.00275581
N = 27514.027
fc = 16.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0035
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0035
we (5.4c) = 0.00
ase ((5.4d), TBDY) = (ase1*Acol1+ase2*Acol2+ase3*Aweb)/Asec = 0.00
ase1 = 0.00
sh_1 = 100.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 100.00
bo_2 = 190.00
ho_2 = 540.00
bi2_2 = 655400.00
ase3 = 0 (grid does not provide confinement)
psh,min = Min(psh,x , psh,y) = 0.0010472

```

```

psh,x = ps1,x+ps2,x+ps3,x = 0.00439823
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00125664
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00125664
h2 = 600.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,x (web) = (As3*h3/s_3)/Ac = 0.00188496
h3 = 1800.00
As3 = Astir3*ns3 = 0.00

```



No stirups, ns3 = 2.00

psh,y = ps1,y+ps2,y+ps3,y = 0.0010472  
ps1,y (column 1) = (As1\*h1/s\_1)/Ac = 0.0005236  
h1 = 250.00  
As1 = Astir1\*ns1 = 157.0796  
No stirups, ns1 = 2.00  
ps2,y (column 2) = (As2\*h2/s\_2)/Ac = 0.0005236  
h2 = 250.00  
As2 = Astir2\*ns2 = 157.0796  
No stirups, ns2 = 2.00  
ps3,y (web) = (As3\*h3/s\_3)/Ac = 0.00  
h3 = 250.00  
As3 = Astir3\*ns3 = 157.0796  
No stirups, ns3 = 0.00

Asec = 750000.00  
s\_1 = 100.00  
s\_2 = 100.00  
s\_3 = 200.00  
fywe = 500.00  
fce = 16.00

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

y1 = 0.00208333

sh1 = 0.00805

ft1 = 600.00

fy1 = 500.00

su1 = 0.03226667

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

lo/lou,min = lb/l\_d = 1.00

su1 = 0.4\*esu1\_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1\_nominal = 0.08066667,

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, ASCE41-17.

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

y2 = 0.00208333

sh2 = 0.00805

ft2 = 600.00

fy2 = 500.00

su2 = 0.03226667

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

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

su2 = 0.4\*esu2\_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2\_nominal = 0.08066667,

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, ASCE41-17.

with fs2 = fs = 500.00

with Es2 = Es = 200000.00

yv = 0.00208333

shv = 0.00805

ftv = 600.00

fyv = 500.00

suv = 0.03226667

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

lo/lou,min = lb/l\_d = 1.00

suv = 0.4\*esuv\_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esuv\_nominal = 0.08066667,

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, ASCE41-17.

with  $f_{sv} = f_s = 500.00$

with  $E_{sv} = E_s = 200000.00$

1 =  $A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.11862785$

2 =  $A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.11862785$

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.08055366$

and confined core properties:

$b = 2940.00$

$d = 178.00$

$d' = 12.00$

$f_{cc}$  (5A.2, TBDY) = 16.00

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

$c$  = confinement factor = 1.00

1 =  $A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.14145031$

2 =  $A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.14145031$

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.09605114$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

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

--->

$su$  (4.9) = 0.2130262

$Mu = MR_c$  (4.14) = 3.1796E+008

$u = su$  (4.1) = 0.00019712

Calculation of ratio  $l_b/l_d$

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

Calculation of  $Mu_{2+}$

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

$u = 0.00019144$

$Mu = 2.4327E+008$

with full section properties:

$b = 3000.00$

$d = 208.00$

$d' = 42.00$

$v = 0.00275581$

$N = 27514.027$

$f_c = 16.00$

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

Final value of  $cu$ :  $cu^* = \text{shear\_factor} \cdot \text{Max}(cu, cc) = 0.0035$

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

From (5.4b), TBDY:  $cu = 0.0035$

$w_e$  (5.4c) = 0.00

$ase$  ((5.4d), TBDY) =  $(ase1 \cdot A_{col1} + ase2 \cdot A_{col2} + ase3 \cdot A_{web})/A_{sec} = 0.00$

$ase1 = 0.00$

$sh_1 = 100.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$ase2 = 0.00$

$sh_2 = 100.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$ase3 = 0$  (grid does not provide confinement)

$$psh,min = \text{Min}(psh,x, psh,y) = 0.0010472$$

$$psh,x = ps1,x+ps2,x+ps3,x = 0.00439823$$

$$ps1,x \text{ (column 1)} = (As1*h1/s_1)/Ac = 0.00125664$$

$$h1 = 600.00$$

$$As1 = Astir1*ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2,x \text{ (column 2)} = (As2*h2/s_2)/Ac = 0.00125664$$

$$h2 = 600.00$$

$$As2 = Astir2*ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3,x \text{ (web)} = (As3*h3/s_3)/Ac = 0.00188496$$

$$h3 = 1800.00$$

$$As3 = Astir3*ns3 = 0.00$$

$$\text{No stirups, } ns3 = 2.00$$

$$psh,y = ps1,y+ps2,y+ps3,y = 0.0010472$$

$$ps1,y \text{ (column 1)} = (As1*h1/s_1)/Ac = 0.0005236$$

$$h1 = 250.00$$

$$As1 = Astir1*ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2,y \text{ (column 2)} = (As2*h2/s_2)/Ac = 0.0005236$$

$$h2 = 250.00$$

$$As2 = Astir2*ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3,y \text{ (web)} = (As3*h3/s_3)/Ac = 0.00$$

$$h3 = 250.00$$

$$As3 = Astir3*ns3 = 157.0796$$

$$\text{No stirups, } ns3 = 0.00$$

$$Asec = 750000.00$$

$$s_1 = 100.00$$

$$s_2 = 100.00$$

$$s_3 = 200.00$$

$$fywe = 500.00$$

$$fce = 16.00$$

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

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

$$y1 = 0.00208333$$

$$sh1 = 0.00805$$

$$ft1 = 600.00$$

$$fy1 = 500.00$$

$$su1 = 0.03226667$$

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

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

$$su1 = 0.4*esu1\_nominal ((5.5), \text{ TBDY}) = 0.03226667$$

$$\text{From table 5A.1, TBDY: } esu1\_nominal = 0.08066667,$$

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

$$y1, sh1,ft1,fy1, \text{ are also multiplied by } \text{Min}(1, 1.25*(lb/l_d)^{2/3}), \text{ from 10.3.5, ASCE41-17.}$$

$$\text{with } fs1 = fs = 500.00$$

$$\text{with } Es1 = Es = 200000.00$$

$$y2 = 0.00208333$$

$$sh2 = 0.00805$$

$$ft2 = 600.00$$

$$fy2 = 500.00$$

$$su2 = 0.03226667$$

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

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

$$su2 = 0.4*esu2\_nominal ((5.5), \text{ TBDY}) = 0.03226667$$

$$\text{From table 5A.1, TBDY: } esu2\_nominal = 0.08066667,$$

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, ASCE41-17.  
 with  $fs2 = fs = 500.00$   
 with  $Es2 = Es = 200000.00$   
 $yv = 0.00208333$   
 $shv = 0.00805$   
 $ftv = 600.00$   
 $fyv = 500.00$   
 $suv = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $lo/lou, min = lb/ld = 1.00$   
 $suv = 0.4 \cdot esuv\_nominal ((5.5), TBDY) = 0.03226667$   
 From table 5A.1, TBDY:  $esuv\_nominal = 0.08066667$ ,  
 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, ASCE41-17.  
 with  $fsv = fs = 500.00$   
 with  $Esv = Es = 200000.00$   
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.11862785$   
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.11862785$   
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00$

and confined core properties:

$b = 2940.00$   
 $d = 178.00$   
 $d' = 12.00$   
 $fcc (5A.2, TBDY) = 16.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.14145031$   
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.14145031$   
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00$

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

---

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

---

$su (4.9) = 0.18965884$   
 $Mu = MRc (4.14) = 2.4327E+008$   
 $u = su (4.1) = 0.00019144$

Calculation of ratio  $lb/ld$

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

Calculation of  $Mu2$ -

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

$u = 0.00019712$   
 $Mu = 3.1796E+008$

with full section properties:

$b = 3000.00$   
 $d = 208.00$   
 $d' = 42.00$   
 $v = 0.00275581$   
 $N = 27514.027$   
 $fc = 16.00$   
 $co (5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = \text{shear\_factor} \cdot \text{Max}(cu, cc) = 0.0035$   
 The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $c_u = 0.0035$   
 $w_e$  (5.4c) = 0.00  
 $a_{se}$  ((5.4d), TBDY) =  $(a_{se1} \cdot A_{col1} + a_{se2} \cdot A_{col2} + a_{se3} \cdot A_{web}) / A_{sec} = 0.00$   
 $a_{se1} = 0.00$   
 $sh_1 = 100.00$   
 $bo_1 = 190.00$   
 $ho_1 = 540.00$   
 $bi2_1 = 655400.00$   
 $a_{se2} = 0.00$   
 $sh_2 = 100.00$   
 $bo_2 = 190.00$   
 $ho_2 = 540.00$   
 $bi2_2 = 655400.00$   
 $a_{se3} = 0$  (grid does not provide confinement)  
 $psh, min = \min(psh, x, psh, y) = 0.0010472$

$psh, x = ps1, x + ps2, x + ps3, x = 0.00439823$   
 $ps1, x$  (column 1) =  $(As1 \cdot h1 / s_1) / A_c = 0.00125664$   
 $h1 = 600.00$   
 $As1 = Astir1 \cdot ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2, x$  (column 2) =  $(As2 \cdot h2 / s_2) / A_c = 0.00125664$   
 $h2 = 600.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3, x$  (web) =  $(As3 \cdot h3 / s_3) / A_c = 0.00188496$   
 $h3 = 1800.00$   
 $As3 = Astir3 \cdot ns3 = 0.00$   
 No stirups,  $ns3 = 2.00$

$psh, y = ps1, y + ps2, y + ps3, y = 0.0010472$   
 $ps1, y$  (column 1) =  $(As1 \cdot h1 / s_1) / A_c = 0.0005236$   
 $h1 = 250.00$   
 $As1 = Astir1 \cdot ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2, y$  (column 2) =  $(As2 \cdot h2 / s_2) / A_c = 0.0005236$   
 $h2 = 250.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3, y$  (web) =  $(As3 \cdot h3 / s_3) / A_c = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 \cdot ns3 = 157.0796$   
 No stirups,  $ns3 = 0.00$

$A_{sec} = 750000.00$   
 $s_1 = 100.00$   
 $s_2 = 100.00$   
 $s_3 = 200.00$

$fy_{we} = 500.00$   
 $f_{ce} = 16.00$

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

$y1 = 0.00208333$

$sh1 = 0.00805$

$ft1 = 600.00$

$fy1 = 500.00$

$su1 = 0.03226667$

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

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

$su1 = 0.4 \cdot esu1_{nominal}$  ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY:  $esu1_{nominal} = 0.08066667$ ,

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, ASCE41-17.

with  $fs1 = fs = 500.00$

```

with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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, ASCE41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785
2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785
v = Asl,mid/(b*d)*(fsv/fc) = 0.08055366
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031
2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031
v = Asl,mid/(b*d)*(fsv/fc) = 0.09605114
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.2130262
Mu = MRc (4.14) = 3.1796E+008
u = su (4.1) = 0.00019712

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 904830.218

Calculation of Shear Strength at edge 1, Vr1 = 904830.218

From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r1} = V_n < 0.83 \cdot f'_c \cdot h \cdot d$

NOTE: In expression (22.5.1.1) 'V<sub>w</sub>' is replaced by 'V<sub>w</sub> + f<sub>r</sub>V<sub>f</sub>' where V<sub>f</sub> is the contribution of FRPs (11.3), ACI 440).

From Table (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$

$\mu_u/\mu_u - l_w/2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f'_c = 16.00$ , but  $f'_c \cdot 0.5 \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$\mu_u = 2.0446822E-012$

$V_u = 2.0366709E-032$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 251327.412$

$V_{s1} = 125663.706$  is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s2} = 125663.706$  is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s3} = 0.00$  is calculated for web, with:

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 400.00$

$V_{s3}$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

$b_w = 3000.00$

Calculation of Shear Strength at edge 2,  $V_{r2} = 904830.218$

From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r2} = V_n < 0.83 \cdot f'_c \cdot h \cdot d$

NOTE: In expression (22.5.1.1) 'V<sub>w</sub>' is replaced by 'V<sub>w</sub> + f<sub>r</sub>V<sub>f</sub>' where V<sub>f</sub> is the contribution of FRPs (11.3), ACI 440).

From Table (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$

$\mu_u/\mu_u - l_w/2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f'_c = 16.00$ , but  $f'_c \cdot 0.5 \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$\mu_u = 2.0446822E-012$

$V_u = 2.0366709E-032$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 251327.412$

$V_{s1} = 125663.706$  is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s2} = 125663.706$  is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

Vs3 = 0.00 is calculated for web, with:

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 400.00$

Vs3 has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

$b_w = 3000.00$

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcrws

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

According to 10.7.2.3, ASCE 41-17, shear walls with transverse reinforcement percentage,  $\gamma < 0.0015$

are considered Force-Controlled and lower-bound strengths are used according to 7.5.1.3, ASCE 41-17

$\gamma = 0.0010472$

with  $\gamma = \gamma_1 + \gamma_2 + \gamma_3$ , being the shear reinf. ratio in a plane perpendicular to the shear axis 2

(pseudo-col.1  $\gamma_1 = A_{s1} \cdot b_1 / s_1 = (A_{s1} \cdot h_1 / s_1) / A_c = 0.0005236$

$h_1 = 250.00$

$s_1 = 100.00$

total area of hoops perpendicular to shear axis,  $A_{s1} = 157.0796$

(pseudo-col.2  $\gamma_2 = A_{s2} \cdot b_2 / s_2 = (A_{s2} \cdot h_2 / s_2) / A_c = 0.0005236$

$h_2 = 250.00$

$s_2 = 100.00$

total area of hoops perpendicular to shear axis,  $A_{s2} = 157.0796$

(grid  $\gamma_3 = A_{s3} \cdot b_3 / s_3 = (A_{s3} \cdot h_3 / s_3) / A_c = 0.00$

$h_3 = 250.00$

$s_3 = 200.00$

total area of hoops perpendicular to shear axis,  $A_{s3} = 0.00$

total section area,  $A_c = 750000.00$

Consequently:

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,  $E_s = 200000.00$

Total Height,  $H_{tot} = 3000.00$

Edges Width,  $W_{edg} = 250.00$

Edges Height,  $H_{edg} = 600.00$

Web Width,  $W_{web} = 250.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties



Bending Moment,  $M = -1.6181356E-010$   
 Shear Force,  $V2 = -7.9731059E-014$   
 Shear Force,  $V3 = -31682.313$   
 Axial Force,  $F = -27619.81$   
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
   -Tension:  $As_t = 0.00$   
   -Compression:  $As_c = 6346.017$   
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $As_{ten} = 2368.761$   
   -Compression:  $As_{com} = 2368.761$   
   -Middle:  $As_{mid} = 1608.495$   
 Mean Diameter of Tension Reinforcement,  $Db_L = 17.20$

Existing component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u_R = u = 0.00985819$   
 $u = y + p = 0.00985819$

- Calculation of  $y$  -

$y = (M_y * I_p) / (EI)_{Eff} = 0.00185819$  ((10-5), ASCE 41-17))  
 $M_y = 2.2250E+008$   
 $(EI)_{Eff} = 0.35 * E_c * I$  (table 10-5)  
 $E_c * I = 8.2106E+013$   
 $I_p = 0.5 * d = 0.5 * (0.8 * h) = 240.00$

Calculation of Yielding Moment  $M_y$

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

$y = \text{Min}(y_{ten}, y_{com})$   
 $y_{ten} = 1.2992461E-005$   
 with  $f_y = 400.00$   
 $d = 208.00$   
 $y = 0.25992587$   
 $A = 0.01028056$   
 $B = 0.00622237$   
 with  $pt = 0.00379609$   
 $pc = 0.00379609$   
 $pv = 0.00257772$   
 $N = 27619.81$   
 $b = 3000.00$   
 $" = 0.20192308$   
 $y_{comp} = 2.5448357E-005$   
 with  $f_c = 16.00$   
 $E_c = 21019.039$   
 $y = 0.25885499$   
 $A = 0.01000838$   
 $B = 0.00611172$   
 with  $E_s = 200000.00$

Calculation of ratio  $l_b/d$

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

- Calculation of  $p$  -

Considering wall controlled by flexure (shear control ratio  $\leq 1$ ),  
 from table 10-19:  $p = 0.008$   
 with:

- Condition i (shear wall and wall segments)
- $(A_s - A_s') \cdot f_y + P) / (t_w \cdot l_w \cdot f_c') = -0.20923225$ 
  - $A_s = 0.00$
  - $A_s' = 6346.017$
  - $f_y = 400.00$
  - $P = 27619.81$
  - $t_w = 3000.00$
  - $l_w = 250.00$
  - $f_c = 16.00$
- $V / (t_w \cdot l_w \cdot f_c'^{0.5}) = 3.2005861E-019$ , NOTE: units in lb & in
- Confined Boundary: No
- Boundary hoops spacing does not exceed  $8d_b$  ( $s_1 < 8 \cdot d_b$  and  $s_2 < 8 \cdot d_b$ )
- Boundary Trans. Reinf. does not exceed 50% of ACI 318 provision ( $V_{w1} + V_{w2} > 0.50 \cdot (V - V_c - V_{w3})$ )
- With
- Boundary Element 1:
  - $V_{w1} = 125663.706$
  - $s_1 = 100.00$
- Boundary Element 2:
  - $V_{w2} = 125663.706$
  - $s_2 = 100.00$
- Grid Shear Force,  $V_{w3} = 0.00$
- Concrete Shear Force,  $V_c = 152084.559$
- (The variables above have already been given in Shear control ratio calculation)
- Mean diameter of all bars,  $d_b = 17.33333$
- Design Shear Force,  $V = 7.9731059E-014$

-----

End Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (a)

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## Calculation No. 13

wall W1, Floor 1

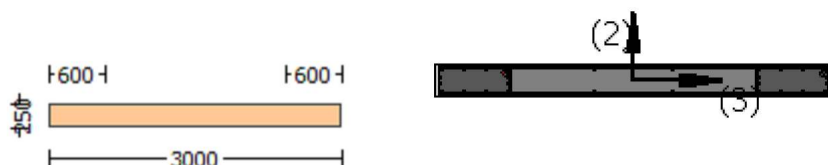
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity  $V_{Rd}$

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcw

Constant Properties

Knowledge Factor,  $\gamma = 1.00$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.

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

Consequently:

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,  $E_s = 200000.00$

Total Height,  $H_{tot} = 3000.00$

Edges Width,  $W_{edg} = 250.00$

Edges Height,  $H_{edg} = 600.00$

Web Width,  $W_{web} = 250.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment,  $M_a = -1.6181356E-010$

Shear Force,  $V_a = -7.9731059E-014$

EDGE -B-

Bending Moment,  $M_b = -7.7792062E-011$

Shear Force,  $V_b = 7.9731059E-014$

BOTH EDGES

Axial Force,  $F = -27619.81$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $A_{sl,t} = 0.00$

-Compression:  $A_{sl,c} = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $A_{sl,ten} = 2368.761$

-Compression:  $A_{sl,com} = 2368.761$

-Middle:  $A_{sl,mid} = 1608.495$

Mean Diameter of Tension Reinforcement,  $Db_{L,ten} = 17.20$

Existing component: From table 7-7, ASCE 41\_17: Final Shear Capacity  $V_R = V_n = 443157.873$   
From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_n < 0.83 \cdot f_c' \cdot h \cdot d = 443157.873$

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

From Table (11.5.4.6(d-e)), ACI 318-14:  $V_c = 191830.46$

$\mu_u / \mu_l = 850.6808 > 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$ , but  $f_c'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$\mu_u = 7.7792062E-011$

$V_u = 7.9731059E-014$

$N_u = 27619.81$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 251327.412$

$V_{s1} = 125663.706$  is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s2} = 125663.706$  is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s3} = 0.00$  is calculated for web, with:

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 400.00$

$V_{s3}$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

$b_w = 3000.00$

End Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (b)

## Calculation No. 14

wall W1, Floor 1

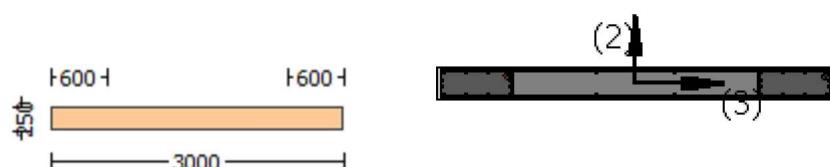
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity ( $\phi_u$ )

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcrws

Constant Properties

Knowledge Factor,  $K = 1.00$

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

Consequently:

Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 16.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 400.00$

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

Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 500.00$

#####

Total Height,  $H_{tot} = 3000.00$

Edges Width,  $W_{edg} = 250.00$

Edges Height,  $H_{edg} = 600.00$

Web Width,  $W_{web} = 250.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force,  $V_a = -3.6423187\text{E}-030$

EDGE -B-

Shear Force,  $V_b = 3.6423187\text{E}-030$

BOTH EDGES

Axial Force,  $F = -27514.027$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $As_t = 0.00$

-Compression:  $As_c = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{t,ten} = 2865.133$

-Compression:  $As_{c,com} = 2865.133$

-Middle:  $As_{mid} = 0.00$

(According to 10.7.2.3  $As_{mid}$  is setted equal to zero)

Calculation of Shear Capacity ratio,  $V_e/V_r = 2.25608$

Member Controlled by Shear ( $V_e/V_r > 1$ )

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n = 3.8558\text{E}+006$  with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 5.7837\text{E}+009$

$M_{u1+} = 5.0210\text{E}+009$ , 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

$M_{u1-} = 5.7837\text{E}+009$ , 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

$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 5.7837\text{E}+009$

$M_{u2+} = 5.0210\text{E}+009$ , 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

$M_{u2-} = 5.7837\text{E}+009$ , 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

Calculation of  $M_{u1+}$

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

$\phi_u = 1.1673539\text{E}-005$

$M_u = 5.0210\text{E}+009$

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$

$v = 0.00232618$

$N = 27514.027$

$f_c = 16.00$

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

Final value of  $\phi_u$ :  $\phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.0035$

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

From (5.4b), TBDY:  $\phi_u = 0.0035$

$\phi_{we}$  (5.4c) = 0.00

$\phi_{ase}$  ((5.4d), TBDY) =  $(\phi_{ase1} * A_{col1} + \phi_{ase2} * A_{col2} + \phi_{ase3} * A_{web}) / A_{sec} = 0.00$

$\phi_{ase1} = 0.00$

$\phi_{sh\_1} = 100.00$

$\phi_{bo\_1} = 190.00$

$\phi_{ho\_1} = 540.00$

$\phi_{bi2\_1} = 655400.00$

$\phi_{ase2} = 0.00$

$\phi_{sh\_2} = 100.00$

$\phi_{bo\_2} = 190.00$

$\phi_{ho\_2} = 540.00$

$\phi_{bi2\_2} = 655400.00$

$\phi_{ase3} = 0$  (grid does not provide confinement)

$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.0010472$

$psh,x = ps1,x + ps2,x + ps3,x = 0.00439823$   
 $ps1,x \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00125664$   
 $h1 = 600.00$   
 $As1 = Astir1 \cdot ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,x \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00125664$   
 $h2 = 600.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,x \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00188496$   
 $h3 = 1800.00$   
 $As3 = Astir3 \cdot ns3 = 0.00$   
 No stirups,  $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.0010472$   
 $ps1,y \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.0005236$   
 $h1 = 250.00$   
 $As1 = Astir1 \cdot ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.0005236$   
 $h2 = 250.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,y \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 \cdot ns3 = 157.0796$   
 No stirups,  $ns3 = 0.00$

$Asec = 750000.00$   
 $s_1 = 100.00$   
 $s_2 = 100.00$   
 $s_3 = 200.00$   
 $fywe = 500.00$   
 $fce = 16.00$

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

$y1 = 0.00208333$

$sh1 = 0.00805$

$ft1 = 600.00$

$fy1 = 500.00$

$su1 = 0.03226667$

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

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

$su1 = 0.4 \cdot esu1\_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fs1 = fs = 500.00$

with  $Es1 = Es = 200000.00$

$y2 = 0.00208333$

$sh2 = 0.00805$

$ft2 = 600.00$

$fy2 = 500.00$

$su2 = 0.03226667$

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

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

$su2 = 0.4 \cdot esu2\_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fs2 = fs = 500.00$

```

with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652
2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723
2 = Asl,com/(b*d)*(fs2/fc) = 0.16099723
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.06523978
Mu = MRc (4.14) = 5.0210E+009
u = su (4.1) = 1.1673539E-005

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

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

```

u = 1.1958028E-005
Mu = 5.7837E+009

```

with full section properties:

```

b = 250.00
d = 2957.00
d' = 43.00
v = 0.00232618
N = 27514.027
fc = 16.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0035
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0035
we (5.4c) = 0.00

```



$$ase((5.4d), TBDY) = (ase1 \cdot Acol1 + ase2 \cdot Acol2 + ase3 \cdot Aweb) / Asec = 0.00$$

$$ase1 = 0.00$$

$$sh_1 = 100.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$ase2 = 0.00$$

$$sh_2 = 100.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$ase3 = 0 \text{ (grid does not provide confinement)}$$

$$psh, min = \min(psh, x, psh, y) = 0.0010472$$

$$psh, x = ps1, x + ps2, x + ps3, x = 0.00439823$$

$$ps1, x \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00125664$$

$$h1 = 600.00$$

$$As1 = Astir1 \cdot ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2, x \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00125664$$

$$h2 = 600.00$$

$$As2 = Astir2 \cdot ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3, x \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00188496$$

$$h3 = 1800.00$$

$$As3 = Astir3 \cdot ns3 = 0.00$$

$$\text{No stirups, } ns3 = 2.00$$

$$psh, y = ps1, y + ps2, y + ps3, y = 0.0010472$$

$$ps1, y \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.0005236$$

$$h1 = 250.00$$

$$As1 = Astir1 \cdot ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2, y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.0005236$$

$$h2 = 250.00$$

$$As2 = Astir2 \cdot ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3, y \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00$$

$$h3 = 250.00$$

$$As3 = Astir3 \cdot ns3 = 157.0796$$

$$\text{No stirups, } ns3 = 0.00$$

$$Asec = 750000.00$$

$$s_1 = 100.00$$

$$s_2 = 100.00$$

$$s_3 = 200.00$$

$$fywe = 500.00$$

$$fce = 16.00$$

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

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

$$y1 = 0.00208333$$

$$sh1 = 0.00805$$

$$ft1 = 600.00$$

$$fy1 = 500.00$$

$$su1 = 0.03226667$$

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

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

$$su1 = 0.4 \cdot esu1\_nominal((5.5), TBDY) = 0.03226667$$

$$\text{From table 5A.1, TBDY: } esu1\_nominal = 0.08066667,$$

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

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \min(1, 1.25 \cdot (lb/l_d)^{2/3}), \text{ from 10.3.5, ASCE41-17.}$$

$$\text{with } fs1 = fs = 500.00$$

$$\text{with } Es1 = Es = 200000.00$$

$$y2 = 0.00208333$$

```

sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb,min = 1.00
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
    From table 5A.1, TBDY: esu2_nominal = 0.08066667,
    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, ASCE41-17.
    with fs2 = fs = 500.00
    with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/ld = 1.00
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
    From table 5A.1, TBDY: esuv_nominal = 0.08066667,
    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, ASCE41-17.
    with fsv = fs = 500.00
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652
2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652
v = Asl,mid/(b*d)*(fsv/fc) = 0.02602943
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723
2 = Asl,com/(b*d)*(fs2/fc) = 0.16099723
v = Asl,mid/(b*d)*(fsv/fc) = 0.03460028
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.8) = 0.08747825
Mu = MRc (4.15) = 5.7837E+009
u = su (4.1) = 1.1958028E-005

```

Calculation of ratio lb/ld

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

Calculation of Mu2+

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

$$u = 1.1673539E-005$$

$$\mu = 5.0210E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.0035$$

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

$$\text{From (5.4b), TB DY: } \phi_u = 0.0035$$

$$w_e (5.4c) = 0.00$$

$$a_{se} ((5.4d), \text{TB DY}) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 100.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 100.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.0010472$$

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00439823$$

$$p_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00125664$$

$$h_1 = 600.00$$

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

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

$$p_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00125664$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$p_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirups, } n_{s3} = 2.00$$

$$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.0010472$$

$$p_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.0005236$$

$$h_1 = 250.00$$

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

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

$$p_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.0005236$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$p_{s3,y} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

$$\text{No stirups, } n_{s3} = 0.00$$

$$A_{sec} = 750000.00$$

$$s_1 = 100.00$$

$$s_2 = 100.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 500.00$$

$$f_{ce} = 16.00$$

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

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

$$y_1 = 0.00208333$$

```

sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 1.00
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
    From table 5A.1, TBDY: esu1_nominal = 0.08066667,
    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, ASCE41-17.
    with fs1 = fs = 500.00
    with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 1.00
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
    From table 5A.1, TBDY: esu2_nominal = 0.08066667,
    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, ASCE41-17.
    with fs2 = fs = 500.00
    with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 1.00
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
    From table 5A.1, TBDY: esuv_nominal = 0.08066667,
    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, ASCE41-17.
    with fsv = fs = 500.00
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652
2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723
    2 = Asl,com/(b*d)*(fs2/fc) = 0.16099723
    v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.06523978

```

$$\begin{aligned} \mu &= M R_c (4.14) = 5.0210E+009 \\ u &= s_u (4.1) = 1.1673539E-005 \end{aligned}$$

Calculation of ratio  $I_b/I_d$

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

Calculation of  $\mu_2$ -

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

$$u = 1.1958028E-005$$

$$\mu = 5.7837E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear\_factor} * \text{Max}(\mu_c, \mu_s) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \mu_c = 0.0035$$

$$\mu_s (5.4c) = 0.00$$

$$a_s ((5.4d), TBDY) = (a_{s1} * A_{col1} + a_{s2} * A_{col2} + a_{s3} * A_{web}) / A_{sec} = 0.00$$

$$a_{s1} = 0.00$$

$$sh_1 = 100.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{s2} = 0.00$$

$$sh_2 = 100.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{s3} = 0 \text{ (grid does not provide confinement)}$$

$$psh_{min} = \text{Min}(psh_x, psh_y) = 0.0010472$$

$$psh_x = ps1_x + ps2_x + ps3_x = 0.00439823$$

$$ps1_x (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00125664$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * ns_1 = 157.0796$$

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

$$ps2_x (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00125664$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * ns_2 = 157.0796$$

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

$$ps3_x (\text{web}) = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * ns_3 = 0.00$$

$$\text{No stirups, } ns_3 = 2.00$$

$$psh_y = ps1_y + ps2_y + ps3_y = 0.0010472$$

$$ps1_y (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.0005236$$

$$h_1 = 250.00$$

$$A_{s1} = A_{stir1} * ns_1 = 157.0796$$

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

$$ps2_y (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.0005236$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * ns_2 = 157.0796$$

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

$$ps_{3,y}(\text{web}) = (As_3 \cdot h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$As_3 = Astir_3 \cdot ns_3 = 157.0796$$

$$\text{No stirrups, } ns_3 = 0.00$$

$$A_{sec} = 750000.00$$

$$s_1 = 100.00$$

$$s_2 = 100.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 500.00$$

$$f_{ce} = 16.00$$

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

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

$$y_1 = 0.00208333$$

$$sh_1 = 0.00805$$

$$ft_1 = 600.00$$

$$fy_1 = 500.00$$

$$su_1 = 0.03226667$$

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

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

$$su_1 = 0.4 \cdot esu_1 \text{ nominal } ((5.5), \text{TB DY}) = 0.03226667$$

$$\text{From table 5A.1, TB DY: } esu_1 \text{ nominal} = 0.08066667,$$

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  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE41-17.

$$\text{with } fs_1 = fs = 500.00$$

$$\text{with } Es_1 = Es = 200000.00$$

$$y_2 = 0.00208333$$

$$sh_2 = 0.00805$$

$$ft_2 = 600.00$$

$$fy_2 = 500.00$$

$$su_2 = 0.03226667$$

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

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

$$su_2 = 0.4 \cdot esu_2 \text{ nominal } ((5.5), \text{TB DY}) = 0.03226667$$

$$\text{From table 5A.1, TB DY: } esu_2 \text{ nominal} = 0.08066667,$$

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, TB DY.

$y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE41-17.

$$\text{with } fs_2 = fs = 500.00$$

$$\text{with } Es_2 = Es = 200000.00$$

$$y_v = 0.00208333$$

$$sh_v = 0.00805$$

$$ft_v = 600.00$$

$$fy_v = 500.00$$

$$suv = 0.03226667$$

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

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

$$suv = 0.4 \cdot esuv \text{ nominal } ((5.5), \text{TB DY}) = 0.03226667$$

$$\text{From table 5A.1, TB DY: } esuv \text{ nominal} = 0.08066667,$$

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

For calculation of  $esuv \text{ nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
characteristic value  $fsyv = fs_v/1.2$ , from table 5.1, TB DY.

$y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE41-17.

$$\text{with } fs_v = fs = 500.00$$

$$\text{with } Es_v = Es = 200000.00$$

$$1 = Asl, \text{ten} / (b \cdot d) \cdot (fs_1 / f_c) = 0.12111652$$

$$2 = Asl, \text{com} / (b \cdot d) \cdot (fs_2 / f_c) = 0.12111652$$

$$v = Asl, \text{mid} / (b \cdot d) \cdot (fs_v / f_c) = 0.02602943$$

and confined core properties:

$$b = 190.00$$

$d = 2927.00$   
 $d' = 13.00$   
 $f_{cc} (5A.2, TBDY) = 16.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.16099723$   
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.16099723$   
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.03460028$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)

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

$\mu_u (4.8) = 0.08747825$   
 $\mu_u = M_{Rc} (4.15) = 5.7837E+009$   
 $u = \mu_u (4.1) = 1.1958028E-005$

Calculation of ratio  $l_b/d$

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

Calculation of Shear Strength  $V_r = \min(V_{r1}, V_{r2}) = 1.7091E+006$

Calculation of Shear Strength at edge 1,  $V_{r1} = 1.7091E+006$   
 From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r1} = V_n < 0.83*f'_c*0.5*h*d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$   
 $\mu_u/V_u - l_w/2 = 0.00 \leq 0$   
 $= 1$  (normal-weight concrete)  
 $f'_c = 16.00$ , but  $f'_c^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $h = 250.00$   
 $d = 2400.00$   
 $l_w = 3000.00$   
 $\mu_u = 2.8146476E-010$   
 $V_u = 3.6423187E-030$   
 $N_u = 27514.027$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0556E+006$   
 $V_{s1} = 301592.895$  is calculated for pseudo-Column 1, with:  
 $d = 480.00$   
 $A_v = 157079.633$   
 $s = 100.00$   
 $f_y = 400.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s2} = 301592.895$  is calculated for pseudo-Column 2, with:  
 $d = 480.00$   
 $A_v = 157079.633$   
 $s = 100.00$   
 $f_y = 400.00$   
 $V_{s2}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_{s3} = 452389.342$  is calculated for web, with:  
 $d = 1440.00$   
 $A_v = 157079.633$   
 $s = 200.00$   
 $f_y = 400.00$   
 $V_{s3}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_f ((11-3)-(11.4), ACI 440) = 0.00$   
 From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$   
 $bw = 250.00$

Calculation of Shear Strength at edge 2,  $V_{r2} = 1.7091E+006$   
From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r2} = V_n < 0.83 \cdot f_c' \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$

$\mu_u / \mu - l_w / 2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$ , but  $f_c'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 2.8146476E-010$

$V_u = 3.6423187E-030$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0556E+006$

$V_{s1} = 301592.895$  is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s2} = 301592.895$  is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s3} = 452389.342$  is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 400.00$

$V_{s3}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

$b_w = 250.00$

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1  
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1  
At Shear local axis: 2  
(Bending local axis: 3)  
Section Type: rcrcws

Constant Properties

Knowledge Factor, = 1.00

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

Consequently:

Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 16.00$

Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 400.00$

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

Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 500.00$

#####

Total Height,  $H_{tot} = 3000.00$

Edges Width,  $W_{edg} = 250.00$



Edges Height,  $H_{edg} = 600.00$   
 Web Width,  $W_{web} = 250.00$   
 Cover Thickness,  $c = 25.00$   
 Mean Confinement Factor overall section = 1.00  
 Element Length,  $L = 3000.00$   
 Primary Member  
 Ribbed Bars  
 Ductile Steel  
 With Detailing for Earthquake Resistance (including stirrups closed at  $135^\circ$ )  
 Longitudinal Bars With Ends Lapped Starting at the End Sections  
 Adequate Lap Length ( $l_o/l_{ou,min} > 1$ )  
 No FRP Wrapping

#### Stepwise Properties

At local axis: 2  
 EDGE -A-  
 Shear Force,  $V_a = -2.0366709E-032$   
 EDGE -B-  
 Shear Force,  $V_b = 2.0366709E-032$   
 BOTH EDGES  
 Axial Force,  $F = -27514.027$   
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
   -Tension:  $As_t = 0.00$   
   -Compression:  $As_c = 6346.017$   
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
   -Tension:  $As_{t,ten} = 2368.761$   
   -Compression:  $As_{c,com} = 2368.761$   
   -Middle:  $As_{mid} = 0.00$   
 (According to 10.7.2.3  $As_{mid}$  is setted equal to zero)

Calculation of Shear Capacity ratio,  $V_e/V_r = 0.23426757$   
 Member Controlled by Flexure ( $V_e/V_r < 1$ )  
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n = 211972.373$   
 with  
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 3.1796E+008$   
 $\mu_{u1+} = 2.4327E+008$ , 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  
 $\mu_{u1-} = 3.1796E+008$ , is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination  
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 3.1796E+008$   
 $\mu_{u2+} = 2.4327E+008$ , is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination  
 $\mu_{u2-} = 3.1796E+008$ , 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

#### Calculation of $\mu_{u1+}$

Calculation of ultimate curvature  $\mu_u$  according to 4.1, Biskinis/Fardis 2013:  
 $\mu_u = 0.00019144$   
 $\mu_u = 2.4327E+008$

with full section properties:

$b = 3000.00$   
 $d = 208.00$   
 $d' = 42.00$   
 $\nu = 0.00275581$   
 $N = 27514.027$   
 $f_c = 16.00$   
 $\omega$  (5A.5, TBDY) = 0.002

Final value of  $cu$ :  $cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.0035$

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

From (5.4b), TBDY:  $cu = 0.0035$

we (5.4c) = 0.00

ase ((5.4d), TBDY) =  $(ase1 * A_{col1} + ase2 * A_{col2} + ase3 * A_{web}) / A_{sec} = 0.00$

ase1 = 0.00

sh\_1 = 100.00

bo\_1 = 190.00

ho\_1 = 540.00

bi2\_1 = 655400.00

ase2 = 0.00

sh\_2 = 100.00

bo\_2 = 190.00

ho\_2 = 540.00

bi2\_2 = 655400.00

ase3 = 0 (grid does not provide confinement)

psh,min =  $\text{Min}(psh,x, psh,y) = 0.0010472$

psh,x =  $ps1,x + ps2,x + ps3,x = 0.00439823$

ps1,x (column 1) =  $(As1 * h1 / s_1) / A_c = 0.00125664$

h1 = 600.00

As1 =  $A_{stir1} * ns1 = 157.0796$

No stirups, ns1 = 2.00

ps2,x (column 2) =  $(As2 * h2 / s_2) / A_c = 0.00125664$

h2 = 600.00

As2 =  $A_{stir2} * ns2 = 157.0796$

No stirups, ns2 = 2.00

ps3,x (web) =  $(As3 * h3 / s_3) / A_c = 0.00188496$

h3 = 1800.00

As3 =  $A_{stir3} * ns3 = 0.00$

No stirups, ns3 = 2.00

psh,y =  $ps1,y + ps2,y + ps3,y = 0.0010472$

ps1,y (column 1) =  $(As1 * h1 / s_1) / A_c = 0.0005236$

h1 = 250.00

As1 =  $A_{stir1} * ns1 = 157.0796$

No stirups, ns1 = 2.00

ps2,y (column 2) =  $(As2 * h2 / s_2) / A_c = 0.0005236$

h2 = 250.00

As2 =  $A_{stir2} * ns2 = 157.0796$

No stirups, ns2 = 2.00

ps3,y (web) =  $(As3 * h3 / s_3) / A_c = 0.00$

h3 = 250.00

As3 =  $A_{stir3} * ns3 = 157.0796$

No stirups, ns3 = 0.00

Asec = 750000.00

s\_1 = 100.00

s\_2 = 100.00

s\_3 = 200.00

fywe = 500.00

fce = 16.00

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

c = confinement factor = 1.00

y1 = 0.00208333

sh1 = 0.00805

ft1 = 600.00

fy1 = 500.00

su1 = 0.03226667

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

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

Shear\_factor = 1.00

lo/lou,min = lb/ld = 1.00

su1 =  $0.4 * esu1\_nominal$  ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,

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, ASCE41-17.  
 with  $fs1 = fs = 500.00$   
 with  $Es1 = Es = 200000.00$   
 $y2 = 0.00208333$   
 $sh2 = 0.00805$   
 $ft2 = 600.00$   
 $fy2 = 500.00$   
 $su2 = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $lo/lou, min = lb/lb, min = 1.00$   
 $su2 = 0.4 \cdot esu2\_nominal ((5.5), TBDY) = 0.03226667$   
 From table 5A.1, TBDY:  $esu2\_nominal = 0.08066667$ ,  
 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, ASCE41-17.  
 with  $fs2 = fs = 500.00$   
 with  $Es2 = Es = 200000.00$   
 $yv = 0.00208333$   
 $shv = 0.00805$   
 $ftv = 600.00$   
 $fyv = 500.00$   
 $suv = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $lo/lou, min = lb/ld = 1.00$   
 $suv = 0.4 \cdot esuv\_nominal ((5.5), TBDY) = 0.03226667$   
 From table 5A.1, TBDY:  $esuv\_nominal = 0.08066667$ ,  
 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, ASCE41-17.  
 with  $fsv = fs = 500.00$   
 with  $Esv = Es = 200000.00$   
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.11862785$   
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.11862785$   
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00$   
 and confined core properties:  
 $b = 2940.00$   
 $d = 178.00$   
 $d' = 12.00$   
 $fcc (5A.2, TBDY) = 16.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.14145031$   
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.14145031$   
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' does not satisfy Eq. (4.3)  
 --->  
 $v < vs, c$  - RHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.18965884$   
 $Mu = MRc (4.14) = 2.4327E+008$   
 $u = su (4.1) = 0.00019144$

-----  
 Calculation of ratio  $lb/ld$   
 -----

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

Calculation of  $Mu1$ -  
 -----

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

$$\phi_u = 0.00019712$$

$$M_u = 3.1796 \times 10^8$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$\nu = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.0035$$

$$\omega_{(5.4c)} = 0.00$$

$$\omega_{(5.4d), TBDY} = (\omega_{s1} * A_{col1} + \omega_{s2} * A_{col2} + \omega_{s3} * A_{web}) / A_{sec} = 0.00$$

$$\omega_{s1} = 0.00$$

$$s_{h1} = 100.00$$

$$b_{o1} = 190.00$$

$$h_{o1} = 540.00$$

$$b_{i2,1} = 655400.00$$

$$\omega_{s2} = 0.00$$

$$s_{h2} = 100.00$$

$$b_{o2} = 190.00$$

$$h_{o2} = 540.00$$

$$b_{i2,2} = 655400.00$$

$$\omega_{s3} = 0 \text{ (grid does not provide confinement)}$$

$$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.0010472$$

$$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00439823$$

$$\phi_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_{h1}) / A_c = 0.00125664$$

$$h_1 = 600.00$$

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

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

$$\phi_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_{h2}) / A_c = 0.00125664$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\phi_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_{h3}) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirups, } n_{s3} = 2.00$$

$$\phi_{sh,y} = \phi_{s1,y} + \phi_{s2,y} + \phi_{s3,y} = 0.0010472$$

$$\phi_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_{h1}) / A_c = 0.0005236$$

$$h_1 = 250.00$$

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

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

$$\phi_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_{h2}) / A_c = 0.0005236$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\phi_{s3,y} \text{ (web)} = (A_{s3} * h_3 / s_{h3}) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

$$\text{No stirups, } n_{s3} = 0.00$$

$$A_{sec} = 750000.00$$

$$s_{h1} = 100.00$$

$$s_{h2} = 100.00$$

$$s_{h3} = 200.00$$

$$f_{ywe} = 500.00$$

$$f_{ce} = 16.00$$

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

```

c = confinement factor = 1.00
y1 = 0.00208333
sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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, ASCE41-17.
with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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, ASCE41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785
2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785
v = Asl,mid/(b*d)*(fsv/fc) = 0.08055366
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031
2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031
v = Asl,mid/(b*d)*(fsv/fc) = 0.09605114
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied

```

--->

$$su(4.9) = 0.2130262$$

$$\mu = M_{Rc}(4.14) = 3.1796E+008$$

$$u = su(4.1) = 0.00019712$$

Calculation of ratio  $I_b/I_d$

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

Calculation of  $\mu_{2+}$

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

$$u = 0.00019144$$

$$\mu = 2.4327E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } cu: cu^* = \text{shear\_factor} * \text{Max}(cu, cc) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } cu = 0.0035$$

$$we(5.4c) = 0.00$$

$$ase((5.4d), TBDY) = (ase1 * A_{col1} + ase2 * A_{col2} + ase3 * A_{web}) / A_{sec} = 0.00$$

$$ase1 = 0.00$$

$$sh_1 = 100.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$ase2 = 0.00$$

$$sh_2 = 100.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$ase3 = 0 \text{ (grid does not provide confinement)}$$

$$psh, \min = \text{Min}(psh, x, psh, y) = 0.0010472$$

$$psh, x = ps1, x + ps2, x + ps3, x = 0.00439823$$

$$ps1, x \text{ (column 1)} = (As1 * h1 / s_1) / A_c = 0.00125664$$

$$h1 = 600.00$$

$$As1 = Astir1 * ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2, x \text{ (column 2)} = (As2 * h2 / s_2) / A_c = 0.00125664$$

$$h2 = 600.00$$

$$As2 = Astir2 * ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3, x \text{ (web)} = (As3 * h3 / s_3) / A_c = 0.00188496$$

$$h3 = 1800.00$$

$$As3 = Astir3 * ns3 = 0.00$$

$$\text{No stirups, } ns3 = 2.00$$

$$psh, y = ps1, y + ps2, y + ps3, y = 0.0010472$$

$$ps1, y \text{ (column 1)} = (As1 * h1 / s_1) / A_c = 0.0005236$$

$$h1 = 250.00$$

$$As1 = Astir1 * ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2, y \text{ (column 2)} = (As2 * h2 / s_2) / A_c = 0.0005236$$

$$h2 = 250.00$$

$As2 = Astir2 * ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,y (web) = (As3 * h3 / s_3) / Ac = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 * ns3 = 157.0796$   
 No stirups,  $ns3 = 0.00$

-----

$Asec = 750000.00$

$s_1 = 100.00$

$s_2 = 100.00$

$s_3 = 200.00$

$fywe = 500.00$

$fce = 16.00$

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

$c =$  confinement factor  $= 1.00$

$y1 = 0.00208333$

$sh1 = 0.00805$

$ft1 = 600.00$

$fy1 = 500.00$

$su1 = 0.03226667$

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

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

$su1 = 0.4 * esu1\_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fs1 = fs = 500.00$

with  $Es1 = Es = 200000.00$

$y2 = 0.00208333$

$sh2 = 0.00805$

$ft2 = 600.00$

$fy2 = 500.00$

$su2 = 0.03226667$

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

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

$su2 = 0.4 * esu2\_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fs2 = fs = 500.00$

with  $Es2 = Es = 200000.00$

$yv = 0.00208333$

$shv = 0.00805$

$ftv = 600.00$

$fyv = 500.00$

$suv = 0.03226667$

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

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

$suv = 0.4 * esuv\_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY:  $esuv\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fsv = fs = 500.00$

with  $Esv = Es = 200000.00$

$1 = Asl,ten / (b * d) * (fs1 / fc) = 0.11862785$

$2 = Asl,com / (b * d) * (fs2 / fc) = 0.11862785$

$v = Asl,mid / (b * d) * (fsv / fc) = 0.00$

and confined core properties:

$$b = 2940.00$$

$$d = 178.00$$

$$d' = 12.00$$

$$fcc(5A.2, TBDY) = 16.00$$

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

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

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.14145031$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.14145031$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.00$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

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

--->

$$s_u(4.9) = 0.18965884$$

$$M_u = M_{Rc}(4.14) = 2.4327E+008$$

$$u = s_u(4.1) = 0.00019144$$

Calculation of ratio  $l_b/d$

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

Calculation of  $M_{u2}$ -

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

$$u = 0.00019712$$

$$M_u = 3.1796E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.0035$$

$$\phi_{we}(5.4c) = 0.00$$

$$a_{se}((5.4d), TBDY) = (a_{se1}*A_{col1} + a_{se2}*A_{col2} + a_{se3}*A_{web})/A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 100.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 100.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.0010472$$

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00439823$$

$$p_{s1,x}(\text{column 1}) = (A_{s1}*h_1/s_1)/A_c = 0.00125664$$

$$h_1 = 600.00$$

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

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

$$p_{s2,x}(\text{column 2}) = (A_{s2}*h_2/s_2)/A_c = 0.00125664$$

$$h_2 = 600.00$$



$As2 = Astir2 * ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,x \text{ (web)} = (As3 * h3 / s_3) / Ac = 0.00188496$   
 $h3 = 1800.00$   
 $As3 = Astir3 * ns3 = 0.00$   
 No stirups,  $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.0010472$   
 $ps1,y \text{ (column 1)} = (As1 * h1 / s_1) / Ac = 0.0005236$   
 $h1 = 250.00$   
 $As1 = Astir1 * ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,y \text{ (column 2)} = (As2 * h2 / s_2) / Ac = 0.0005236$   
 $h2 = 250.00$   
 $As2 = Astir2 * ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,y \text{ (web)} = (As3 * h3 / s_3) / Ac = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 * ns3 = 157.0796$   
 No stirups,  $ns3 = 0.00$

$Asec = 750000.00$   
 $s_1 = 100.00$   
 $s_2 = 100.00$   
 $s_3 = 200.00$   
 $fywe = 500.00$   
 $fce = 16.00$   
 From ((5.A.5), TBDY), TBDY:  $cc = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $y1 = 0.00208333$   
 $sh1 = 0.00805$   
 $ft1 = 600.00$   
 $fy1 = 500.00$   
 $su1 = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $Shear\_factor = 1.00$   
 $lo/lou,min = lb/l_d = 1.00$   
 $su1 = 0.4 * esu1\_nominal \text{ ((5.5), TBDY)} = 0.03226667$   
 From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,  
 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, ASCE41-17.  
 with  $fs1 = fs = 500.00$   
 with  $Es1 = Es = 200000.00$   
 $y2 = 0.00208333$   
 $sh2 = 0.00805$   
 $ft2 = 600.00$   
 $fy2 = 500.00$   
 $su2 = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 $Shear\_factor = 1.00$   
 $lo/lou,min = lb/l_b,min = 1.00$   
 $su2 = 0.4 * esu2\_nominal \text{ ((5.5), TBDY)} = 0.03226667$   
 From table 5A.1, TBDY:  $esu2\_nominal = 0.08066667$ ,  
 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, ASCE41-17.  
 with  $fs2 = fs = 500.00$   
 with  $Es2 = Es = 200000.00$   
 $yv = 0.00208333$   
 $shv = 0.00805$   
 $ftv = 600.00$   
 $fyv = 500.00$   
 $suv = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor

and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $l_o/l_{ou,min} = l_b/l_d = 1.00$   
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.03226667$   
 From table 5A.1, TBDY:  $esuv_{nominal} = 0.08066667$ ,  
 considering characteristic value  $f_{sv} = f_{sv}/1.2$ , from table 5.1, TBDY  
 For calculation of  $esuv_{nominal}$  and  $y_v, sh_v, ft_v, fy_v$ , it is considered  
 characteristic value  $f_{sv} = f_{sv}/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $Min(1, 1.25 * (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE41-17.  
 with  $f_{sv} = f_s = 500.00$   
 with  $E_{sv} = E_s = 200000.00$   
 $1 = A_{sl,ten}/(b*d) * (f_{s1}/f_c) = 0.11862785$   
 $2 = A_{sl,com}/(b*d) * (f_{s2}/f_c) = 0.11862785$   
 $v = A_{sl,mid}/(b*d) * (f_{sv}/f_c) = 0.08055366$   
 and confined core properties:  
 $b = 2940.00$   
 $d = 178.00$   
 $d' = 12.00$   
 $f_{cc} (5A.2, TBDY) = 16.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten}/(b*d) * (f_{s1}/f_c) = 0.14145031$   
 $2 = A_{sl,com}/(b*d) * (f_{s2}/f_c) = 0.14145031$   
 $v = A_{sl,mid}/(b*d) * (f_{sv}/f_c) = 0.09605114$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' does not satisfy Eq. (4.3)  
 --->  
 $v < v_{s,c}$  - RHS eq.(4.5) is satisfied  
 --->  
 $su (4.9) = 0.2130262$   
 $Mu = MR_c (4.14) = 3.1796E+008$   
 $u = su (4.1) = 0.00019712$

Calculation of ratio  $l_b/l_d$

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

Calculation of Shear Strength  $V_r = Min(V_{r1}, V_{r2}) = 904830.218$

Calculation of Shear Strength at edge 1,  $V_{r1} = 904830.218$   
 From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r1} = V_n < 0.83 * f_c'^{0.5} * h * d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$   
 $Mu/V_u - l_w/2 = 0.00 \leq 0$   
 $= 1$  (normal-weight concrete)  
 $f_c' = 16.00$ , but  $f_c'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $h = 3000.00$   
 $d = 200.00$   
 $l_w = 250.00$   
 $Mu = 2.0446822E-012$   
 $V_u = 2.0366709E-032$   
 $Nu = 27514.027$   
 From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 251327.412$   
 $V_{s1} = 125663.706$  is calculated for pseudo-Column 1, with:  
 $d = 200.00$   
 $A_v = 157079.633$   
 $s = 100.00$   
 $f_y = 400.00$   
 $V_{s1}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17, 10.3.4)  
 $V_{s2} = 125663.706$  is calculated for pseudo-Column 2, with:

d = 200.00

Av = 157079.633

s = 100.00

fy = 400.00

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

Vs3 = 0.00 is calculated for web, with:

d = 200.00

Av = 0.00

s = 200.00

fy = 400.00

Vs3 has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

bw = 3000.00

Calculation of Shear Strength at edge 2, Vr2 = 904830.218

From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_r2 = V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14: Vc = 653502.805

$\mu_u/V_u - l_w/2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$ , but  $f_c' \cdot 0.5 \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

h = 3000.00

d = 200.00

lw = 250.00

$\mu_u = 2.0446822E-012$

$V_u = 2.0366709E-032$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 251327.412$

Vs1 = 125663.706 is calculated for pseudo-Column 1, with:

d = 200.00

Av = 157079.633

s = 100.00

fy = 400.00

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

Vs2 = 125663.706 is calculated for pseudo-Column 2, with:

d = 200.00

Av = 157079.633

s = 100.00

fy = 400.00

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

Vs3 = 0.00 is calculated for web, with:

d = 200.00

Av = 0.00

s = 200.00

fy = 400.00

Vs3 has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

bw = 3000.00

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcrcws

## Constant Properties

Knowledge Factor,  $\phi = 1.00$

According to 10.7.2.3, ASCE 41-17, shear walls with transverse reinforcement percentage,  $\rho_n < 0.0015$

are considered Force-Controlled and lower-bound strengths are used according to 7.5.1.3, ASCE 41-17  
 $\rho_n = 0.0010472$

with  $\rho_n = \rho_{n1} + \rho_{n2} + \rho_{n3}$ , being the shear reinf. ratio in a plane perpendicular to the shear axis 3

(pseudo-col.1  $\rho_{n1} = A_{s1} \cdot b_1 / s_1 = (A_{s1} \cdot h_1 / s_1) / A_c = 0.0005236$

$h_1 = 250.00$

$s_1 = 100.00$

total area of hoops perpendicular to shear axis,  $A_{s1} = 157.0796$

(pseudo-col.2  $\rho_{n2} = A_{s2} \cdot b_2 / s_2 = (A_{s2} \cdot h_2 / s_2) / A_c = 0.0005236$

$h_2 = 250.00$

$s_2 = 100.00$

total area of hoops perpendicular to shear axis,  $A_{s2} = 157.0796$

(grid  $\rho_{n3} = A_{s3} \cdot b_3 / s_3 = (A_{s3} \cdot h_3 / s_3) / A_c = 0.00$

$h_3 = 250.00$

$s_3 = 200.00$

total area of hoops perpendicular to shear axis,  $A_{s3} = 0.00$

total section area,  $A_c = 750000.00$

Consequently:

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,  $E_s = 200000.00$

Total Height,  $H_{tot} = 3000.00$

Edges Width,  $W_{edg} = 250.00$

Edges Height,  $H_{edg} = 600.00$

Web Width,  $W_{web} = 250.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

## Stepwise Properties

Axial Force,  $F = -27619.81$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $A_{st} = 0.00$

-Compression:  $A_{sc} = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $A_{st,ten} = 2865.133$

-Compression:  $A_{st,com} = 2865.133$

-Middle:  $A_{st,mid} = 615.7522$

Mean Diameter of Tension Reinforcement,  $D_bL = 17.33333$

Considering wall controlled by Shear (shear control ratio  $> 1$ ),

interstorey drift provided values are calculated

Existing component: From table 7-7, ASCE 41\_17: Final interstorey drift Capacity  $u_{i,R} = \phi \cdot u = 0.015$

from table 10-20:  $u = 0.015$

with:

- Condition i (shear wall and wall segments)

-  $(A_s - A_s') \cdot f_y + P / (t_w \cdot l_w \cdot f_c') = -0.20923225$

$A_s = 0.00$

$A_s' = 6346.017$

fy = 400.00  
P = 27619.81  
tw = 250.00  
lw = 3000.00  
fc = 16.00

-----  
End Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1  
At local axis: 2  
Integration Section: (a)  
-----

**Calculation No. 15**

wall W1, Floor 1  
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)  
Analysis: Uniform +X  
Check: Shear capacity VRd  
Edge: End  
Local Axis: (3)



Start Of Calculation of Shear Capacity for element: wall W1 of floor 1  
At local axis: 3  
Integration Section: (b)  
Section Type: rcwrs

Constant Properties

-----  
Knowledge Factor,  $\gamma = 1.00$   
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.  
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17  
Consequently:  
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,  $E_s = 200000.00$

Total Height, Htot = 3000.00  
 Edges Width, Wedg = 250.00  
 Edges Height, Hedg = 600.00  
 Web Width, Wweb = 250.00  
 Cover Thickness, c = 25.00  
 Element Length, L = 3000.00  
 Primary Member  
 Ribbed Bars  
 Ductile Steel  
 With Detailing for Earthquake Resistance (including stirrups closed at 135°)  
 Longitudinal Bars With Ends Lapped Starting at the End Sections  
 Adequate Lap Length ( $l_o/l_{o,u,min} = l_b/l_d \geq 1$ )  
 No FRP Wrapping

#### Stepwise Properties

EDGE -A-  
 Bending Moment, Ma = 9.5039E+007  
 Shear Force, Va = -31682.313  
 EDGE -B-  
 Bending Moment, Mb = 17822.236  
 Shear Force, Vb = 31682.313  
 BOTH EDGES  
 Axial Force, F = -27619.81  
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
   -Tension: Aslt = 0.00  
   -Compression: Aslc = 6346.017  
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
   -Tension: Asl,ten = 2865.133  
   -Compression: Asl,com = 2865.133  
   -Middle: Asl,mid = 615.7522  
 Mean Diameter of Tension Reinforcement, DbL,ten = 17.33333

Existing component: From table 7-7, ASCE 41\_17: Final Shear Capacity VR =  $V_n = 1.7091E+006$   
 From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d = 1.7091E+006$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653523.962$   
 $M_u/V_u - l_w/2 = -1499.437 \leq 0$   
   = 1 (normal-weight concrete)  
 $f_c' = 16.00$ , but  $f_c' \cdot 0.5 \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
 $h = 250.00$   
 $d = 2400.00$   
 $l_w = 3000.00$   
 $M_u = 17822.236$   
 $V_u = 31682.313$   
 $N_u = 27619.81$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0556E+006$   
 $V_{s1} = 301592.895$  is calculated for pseudo-Column 1, with:

$d = 480.00$   
 $A_v = 157079.633$   
 $s = 100.00$   
 $f_y = 400.00$

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

$V_{s2} = 301592.895$  is calculated for pseudo-Column 2, with:

$d = 480.00$   
 $A_v = 157079.633$   
 $s = 100.00$   
 $f_y = 400.00$

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

$V_{s3} = 452389.342$  is calculated for web, with:

$d = 1440.00$   
 $A_v = 157079.633$   
 $s = 200.00$   
 $f_y = 400.00$   
 Vs3 has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)  
 $V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$   
 From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$   
 $b_w = 250.00$

-----  
 End Of Calculation of Shear Capacity for element: wall W1 of floor 1  
 At local axis: 3  
 Integration Section: (b)  
 -----

Calculation No. 16

wall W1, Floor 1  
 Limit State: Life Safety (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: wall W1 of floor 1  
 At Shear local axis: 3  
 (Bending local axis: 2)  
 Section Type: rcwrs

Constant Properties

-----  
 Knowledge Factor,  $\phi = 1.00$   
 Mean strength values are used for both shear and moment calculations.  
 Consequently:  
 Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 16.00$   
 Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 400.00$   
 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

Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 500.00$

#####

Total Height,  $H_{tot} = 3000.00$

Edges Width,  $W_{edg} = 250.00$

Edges Height,  $H_{edg} = 600.00$

Web Width,  $W_{web} = 250.00$

Cover Thickness,  $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

#### Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force,  $V_a = -3.6423187E-030$

EDGE -B-

Shear Force,  $V_b = 3.6423187E-030$

BOTH EDGES

Axial Force,  $F = -27514.027$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension:  $As_t = 0.00$

-Compression:  $As_c = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension:  $As_{t,ten} = 2865.133$

-Compression:  $As_{l,com} = 2865.133$

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

(According to 10.7.2.3  $As_{l,mid}$  is setted equal to zero)

Calculation of Shear Capacity ratio,  $V_e/V_r = 2.25608$

Member Controlled by Shear ( $V_e/V_r > 1$ )

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n = 3.8558E+006$   
with

$M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 5.7837E+009$

$\mu_{u1+} = 5.0210E+009$ , 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

$\mu_{u1-} = 5.7837E+009$ , 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

$M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 5.7837E+009$

$\mu_{u2+} = 5.0210E+009$ , 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

$\mu_{u2-} = 5.7837E+009$ , 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

#### Calculation of $\mu_{u1+}$

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

$\mu_u = 1.1673539E-005$

$\mu_u = 5.0210E+009$

with full section properties:

$b = 250.00$

$d = 2957.00$



$d' = 43.00$   
 $v = 0.00232618$   
 $N = 27514.027$   
 $f_c = 16.00$   
 $\phi (5A.5, TBDY) = 0.002$   
 Final value of  $\phi$ :  $\phi^* = \text{shear\_factor} * \text{Max}(\phi, \phi_c) = 0.0035$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $\phi = 0.0035$   
 $\phi (5.4c) = 0.00$   
 $\phi ((5.4d), TBDY) = (\phi_1 * A_{col1} + \phi_2 * A_{col2} + \phi_3 * A_{web}) / A_{sec} = 0.00$   
 $\phi_1 = 0.00$   
 $s_1 = 100.00$   
 $b_1 = 190.00$   
 $h_1 = 540.00$   
 $b_{12} = 655400.00$   
 $\phi_2 = 0.00$   
 $s_2 = 100.00$   
 $b_2 = 190.00$   
 $h_2 = 540.00$   
 $b_{12} = 655400.00$   
 $\phi_3 = 0$  (grid does not provide confinement)  
 $\phi_{min} = \text{Min}(\phi_x, \phi_y) = 0.0010472$

$\phi_x = \phi_{1,x} + \phi_{2,x} + \phi_{3,x} = 0.00439823$   
 $\phi_{1,x} (\text{column 1}) = (A_s1 * h_1 / s_1) / A_c = 0.00125664$   
 $h_1 = 600.00$   
 $A_s1 = A_{stir1} * n_{s1} = 157.0796$   
 No stirups,  $n_{s1} = 2.00$   
 $\phi_{2,x} (\text{column 2}) = (A_s2 * h_2 / s_2) / A_c = 0.00125664$   
 $h_2 = 600.00$   
 $A_s2 = A_{stir2} * n_{s2} = 157.0796$   
 No stirups,  $n_{s2} = 2.00$   
 $\phi_{3,x} (\text{web}) = (A_s3 * h_3 / s_3) / A_c = 0.00188496$   
 $h_3 = 1800.00$   
 $A_s3 = A_{stir3} * n_{s3} = 0.00$   
 No stirups,  $n_{s3} = 2.00$

$\phi_y = \phi_{1,y} + \phi_{2,y} + \phi_{3,y} = 0.0010472$   
 $\phi_{1,y} (\text{column 1}) = (A_s1 * h_1 / s_1) / A_c = 0.0005236$   
 $h_1 = 250.00$   
 $A_s1 = A_{stir1} * n_{s1} = 157.0796$   
 No stirups,  $n_{s1} = 2.00$   
 $\phi_{2,y} (\text{column 2}) = (A_s2 * h_2 / s_2) / A_c = 0.0005236$   
 $h_2 = 250.00$   
 $A_s2 = A_{stir2} * n_{s2} = 157.0796$   
 No stirups,  $n_{s2} = 2.00$   
 $\phi_{3,y} (\text{web}) = (A_s3 * h_3 / s_3) / A_c = 0.00$   
 $h_3 = 250.00$   
 $A_s3 = A_{stir3} * n_{s3} = 157.0796$   
 No stirups,  $n_{s3} = 0.00$

$A_{sec} = 750000.00$   
 $s_1 = 100.00$   
 $s_2 = 100.00$   
 $s_3 = 200.00$

$f_{ywe} = 500.00$   
 $f_{ce} = 16.00$

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

$y_1 = 0.00208333$   
 $s_1 = 0.00805$   
 $f_{t1} = 600.00$   
 $f_{y1} = 500.00$   
 $s_u1 = 0.03226667$

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

```

lo/lou,min = lb/d = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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, ASCE41-17.
with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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, ASCE41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652
2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723
2 = Asl,com/(b*d)*(fs2/fc) = 0.16099723
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
---->
v < vs,y2 - LHS eq.(4.5) is satisfied
---->
su (4.9) = 0.06523978
Mu = MRc (4.14) = 5.0210E+009
u = su (4.1) = 1.1673539E-005

```

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu1-

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

$$\phi_u = 1.1958028E-005$$

$$M_u = 5.7837E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$\nu = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear\_factor} * \text{Max}(\phi_u, \phi_c) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.0035$$

$$\phi_{we} \text{ (5.4c)} = 0.00$$

$$\phi_{ase} \text{ ((5.4d), TBDY)} = (\phi_{ase1} * A_{col1} + \phi_{ase2} * A_{col2} + \phi_{ase3} * A_{web}) / A_{sec} = 0.00$$

$$\phi_{ase1} = 0.00$$

$$sh_1 = 100.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$\phi_{ase2} = 0.00$$

$$sh_2 = 100.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$\phi_{ase3} = 0 \text{ (grid does not provide confinement)}$$

$$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.0010472$$

$$\phi_{psh,x} = \phi_{ps1,x} + \phi_{ps2,x} + \phi_{ps3,x} = 0.00439823$$

$$\phi_{ps1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00125664$$

$$h_1 = 600.00$$

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

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

$$\phi_{ps2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00125664$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\phi_{ps3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirups, } n_{s3} = 2.00$$

$$\phi_{psh,y} = \phi_{ps1,y} + \phi_{ps2,y} + \phi_{ps3,y} = 0.0010472$$

$$\phi_{ps1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.0005236$$

$$h_1 = 250.00$$

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

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

$$\phi_{ps2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.0005236$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\phi_{ps3,y} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

$$\text{No stirups, } n_{s3} = 0.00$$

$$A_{sec} = 750000.00$$

$$s_1 = 100.00$$

```

s_2 = 100.00
s_3 = 200.00
fywe = 500.00
fce = 16.00
From ((5A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00208333
sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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, ASCE41-17.
with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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, ASCE41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652
2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652
v = Asl,mid/(b*d)*(fsv/fc) = 0.02602943
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723
2 = Asl,com/(b*d)*(fs2/fc) = 0.16099723

```

```

v = Asl,mid/(b*d)*(fsv/fc) = 0.03460028
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.8) = 0.08747825
Mu = MRc (4.15) = 5.7837E+009
u = su (4.1) = 1.1958028E-005
-----

Calculation of ratio lb/d
-----
Adequate Lap Length: lb/d >= 1
-----
-----
Calculation of Mu2+
-----
-----
Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.1673539E-005
Mu = 5.0210E+009
-----
with full section properties:
b = 250.00
d = 2957.00
d' = 43.00
v = 0.00232618
N = 27514.027
fc = 16.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0035
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0035
we (5.4c) = 0.00
ase ((5.4d), TBDY) = (ase1*Acol1+ase2*Acol2+ase3*Aweb)/Asec = 0.00
ase1 = 0.00
sh_1 = 100.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 100.00
bo_2 = 190.00
ho_2 = 540.00
bi2_2 = 655400.00
ase3 = 0 (grid does not provide confinement)
psh,min = Min(psh,x , psh,y) = 0.0010472
-----
psh,x = ps1,x+ps2,x+ps3,x = 0.00439823
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00125664
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00125664
h2 = 600.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,x (web) = (As3*h3/s_3)/Ac = 0.00188496
h3 = 1800.00
As3 = Astir3*ns3 = 0.00
No stirups, ns3 = 2.00
-----

```

$psh,y = ps1,y + ps2,y + ps3,y = 0.0010472$   
 $ps1,y \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.0005236$   
 $h1 = 250.00$   
 $As1 = Astir1 \cdot ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.0005236$   
 $h2 = 250.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,y \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 \cdot ns3 = 157.0796$   
 No stirups,  $ns3 = 0.00$

-----  
 $Asec = 750000.00$

$s_1 = 100.00$

$s_2 = 100.00$

$s_3 = 200.00$

$fywe = 500.00$

$fce = 16.00$

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

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

$y1 = 0.00208333$

$sh1 = 0.00805$

$ft1 = 600.00$

$fy1 = 500.00$

$su1 = 0.03226667$

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

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

$su1 = 0.4 \cdot esu1\_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fs1 = fs = 500.00$

with  $Es1 = Es = 200000.00$

$y2 = 0.00208333$

$sh2 = 0.00805$

$ft2 = 600.00$

$fy2 = 500.00$

$su2 = 0.03226667$

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

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

$su2 = 0.4 \cdot esu2\_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fs2 = fs = 500.00$

with  $Es2 = Es = 200000.00$

$yv = 0.00208333$

$shv = 0.00805$

$ftv = 600.00$

$fyv = 500.00$

$suv = 0.03226667$

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

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

$suv = 0.4 \cdot esuv\_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY:  $esuv\_nominal = 0.08066667$ ,

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

characteristic value  $f_{sv} = f_{sv}/1.2$ , from table 5.1, TBDY.  
 $y_1, sh_1, ft_1, f_{y1}$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE41-17.  
 with  $f_{sv} = f_s = 500.00$   
 with  $E_{sv} = E_s = 200000.00$   
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.12111652$   
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.12111652$   
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$   
 and confined core properties:  
 $b = 190.00$   
 $d = 2927.00$   
 $d' = 13.00$   
 $f_{cc} \text{ (5A.2, TBDY)} = 16.00$   
 $cc \text{ (5A.5, TBDY)} = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.16099723$   
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.16099723$   
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$   
 Case/Assumption: Unconfined full section - Steel rupture  
 ' satisfies Eq. (4.3)  
 --->  
 $v < v_{s,y2}$  - LHS eq.(4.5) is satisfied  
 --->  
 $su \text{ (4.9)} = 0.06523978$   
 $Mu = MR_c \text{ (4.14)} = 5.0210E+009$   
 $u = su \text{ (4.1)} = 1.1673539E-005$

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

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

Calculation of  $Mu_2$ -  
 -----  
 -----  
 -----

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

$u = 1.1958028E-005$   
 $Mu = 5.7837E+009$   
 -----

with full section properties:

$b = 250.00$   
 $d = 2957.00$   
 $d' = 43.00$   
 $v = 0.00232618$   
 $N = 27514.027$   
 $f_c = 16.00$   
 $co \text{ (5A.5, TBDY)} = 0.002$   
 Final value of  $cu$ :  $cu^* = \text{shear\_factor} \cdot \text{Max}(cu, cc) = 0.0035$   
 The Shear\_factor is considered equal to 1 (pure moment strength)  
 From (5.4b), TBDY:  $cu = 0.0035$   
 $w_e \text{ (5.4c)} = 0.00$   
 $ase \text{ ((5.4d), TBDY)} = (ase1 \cdot A_{col1} + ase2 \cdot A_{col2} + ase3 \cdot A_{web})/A_{sec} = 0.00$   
 $ase1 = 0.00$   
 $sh_1 = 100.00$   
 $bo_1 = 190.00$   
 $ho_1 = 540.00$   
 $bi2_1 = 655400.00$   
 $ase2 = 0.00$   
 $sh_2 = 100.00$   
 $bo_2 = 190.00$   
 $ho_2 = 540.00$   
 $bi2_2 = 655400.00$   
 $ase3 = 0$  (grid does not provide confinement)  
 $psh_{min} = \text{Min}(psh_x, psh_y) = 0.0010472$   
 -----

$psh,x = ps1,x + ps2,x + ps3,x = 0.00439823$   
 $ps1,x \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00125664$   
 $h1 = 600.00$   
 $As1 = Astir1 \cdot ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,x \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00125664$   
 $h2 = 600.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,x \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00188496$   
 $h3 = 1800.00$   
 $As3 = Astir3 \cdot ns3 = 0.00$   
 No stirups,  $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.0010472$   
 $ps1,y \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.0005236$   
 $h1 = 250.00$   
 $As1 = Astir1 \cdot ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.0005236$   
 $h2 = 250.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3,y \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 \cdot ns3 = 157.0796$   
 No stirups,  $ns3 = 0.00$

$Asec = 750000.00$   
 $s_1 = 100.00$   
 $s_2 = 100.00$   
 $s_3 = 200.00$   
 $fywe = 500.00$   
 $fce = 16.00$

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

$y1 = 0.00208333$   
 $sh1 = 0.00805$   
 $ft1 = 600.00$   
 $fy1 = 500.00$   
 $su1 = 0.03226667$

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

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

$su1 = 0.4 \cdot esu1\_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY:  $esu1\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fs1 = fs = 500.00$

with  $Es1 = Es = 200000.00$

$y2 = 0.00208333$   
 $sh2 = 0.00805$   
 $ft2 = 600.00$   
 $fy2 = 500.00$   
 $su2 = 0.03226667$

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

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

$su2 = 0.4 \cdot esu2\_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY:  $esu2\_nominal = 0.08066667$ ,

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, ASCE41-17.

with  $fs2 = fs = 500.00$



```

with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12111652
2 = Asl,com/(b*d)*(fs2/fc) = 0.12111652
v = Asl,mid/(b*d)*(fsv/fc) = 0.02602943
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.16099723
2 = Asl,com/(b*d)*(fs2/fc) = 0.16099723
v = Asl,mid/(b*d)*(fsv/fc) = 0.03460028
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.8) = 0.08747825
Mu = MRc (4.15) = 5.7837E+009
u = su (4.1) = 1.1958028E-005

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength  $V_r = \min(V_{r1}, V_{r2}) = 1.7091E+006$

Calculation of Shear Strength at edge 1,  $V_{r1} = 1.7091E+006$   
From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r1} = V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$   
 $\mu_u/V_u - l_w/2 = 0.00 \leq 0$   
= 1 (normal-weight concrete)  
 $f_c' = 16.00$ , but  $f_c'^{0.5} \leq 8.3$  MPa (22.5.3.1, ACI 318-14)  
h = 250.00  
d = 2400.00  
lw = 3000.00  
 $\mu_u = 2.8146476E-010$   
 $V_u = 3.6423187E-030$

Nu = 27514.027

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0556E+006$

$V_{s1} = 301592.895$  is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s2} = 301592.895$  is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s3} = 452389.342$  is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 400.00$

$V_{s3}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

$bw = 250.00$

Calculation of Shear Strength at edge 2,  $V_{r2} = 1.7091E+006$

From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r2} = V_n < 0.83 \cdot f_c'^{0.5} \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$

$\mu_u / \mu_u - l_w / 2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$ , but  $f_c'^{0.5} \leq 8.3 \text{ MPa}$  (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 2.8146476E-010$

$V_u = 3.6423187E-030$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0556E+006$

$V_{s1} = 301592.895$  is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s2} = 301592.895$  is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s3} = 452389.342$  is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 400.00$

$V_{s3}$  has been multiplied by 1 ( $s < d/2$ , according to ASCE 41-17,10.3.4)

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

$bw = 250.00$

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1  
At Shear local axis: 2  
(Bending local axis: 3)  
Section Type: rcrcws

Constant Properties

---

Knowledge Factor,  $\phi = 1.00$   
Mean strength values are used for both shear and moment calculations.  
Consequently:  
Existing material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 16.00$   
Existing material of Primary Member: Steel Strength,  $f_s = f_{sm} = 400.00$   
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  
Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 500.00$   
#####  
Total Height,  $H_{tot} = 3000.00$   
Edges Width,  $W_{edg} = 250.00$   
Edges Height,  $H_{edg} = 600.00$   
Web Width,  $W_{web} = 250.00$   
Cover Thickness,  $c = 25.00$   
Mean Confinement Factor overall section = 1.00  
Element Length,  $L = 3000.00$   
Primary Member  
Ribbed Bars  
Ductile Steel  
With Detailing for Earthquake Resistance (including stirrups closed at  $135^\circ$ )  
Longitudinal Bars With Ends Lapped Starting at the End Sections  
Adequate Lap Length ( $l_o/l_{ou,min} \geq 1$ )  
No FRP Wrapping

---

Stepwise Properties

---

At local axis: 2  
EDGE -A-  
Shear Force,  $V_a = -2.0366709E-032$   
EDGE -B-  
Shear Force,  $V_b = 2.0366709E-032$   
BOTH EDGES  
Axial Force,  $F = -27514.027$   
Longitudinal Reinforcement Area Distribution (in 2 divisions)  
-Tension:  $A_{sl,t} = 0.00$   
-Compression:  $A_{sl,c} = 6346.017$   
Longitudinal Reinforcement Area Distribution (in 3 divisions)  
-Tension:  $A_{sl,ten} = 2368.761$   
-Compression:  $A_{sl,com} = 2368.761$   
-Middle:  $A_{sl,mid} = 0.00$   
(According to 10.7.2.3  $A_{sl,mid}$  is setted equal to zero)

---



---

Calculation of Shear Capacity ratio ,  $V_e/V_r = 0.23426757$   
Member Controlled by Flexure ( $V_e/V_r < 1$ )  
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n = 211972.373$   
with  
 $M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 3.1796E+008$   
 $M_{u1+} = 2.4327E+008$ , 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  
 $M_{u1-} = 3.1796E+008$ , 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

$$M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 3.1796E+008$$

$Mu_{2+} = 2.4327E+008$ , 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

$Mu_{2-} = 3.1796E+008$ , 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

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

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

$$\phi_u = 0.00019144$$

$$Mu = 2.4327E+008$$

-----  
with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear\_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.0035$$

$$\phi_{we} (5.4c) = 0.00$$

$$\phi_{ase} ((5.4d), \text{TBDY}) = (\phi_{ase1} * A_{col1} + \phi_{ase2} * A_{col2} + \phi_{ase3} * A_{web}) / A_{sec} = 0.00$$

$$\phi_{ase1} = 0.00$$

$$sh\_1 = 100.00$$

$$bo\_1 = 190.00$$

$$ho\_1 = 540.00$$

$$bi2\_1 = 655400.00$$

$$\phi_{ase2} = 0.00$$

$$sh\_2 = 100.00$$

$$bo\_2 = 190.00$$

$$ho\_2 = 540.00$$

$$bi2\_2 = 655400.00$$

$$\phi_{ase3} = 0 \text{ (grid does not provide confinement)}$$

$$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.0010472$$

$$\phi_{psh,x} = \phi_{ps1,x} + \phi_{ps2,x} + \phi_{ps3,x} = 0.00439823$$

$$\phi_{ps1,x} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00125664$$

$$h_1 = 600.00$$

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

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

$$\phi_{ps2,x} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00125664$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\phi_{ps3,x} (\text{web}) = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirups, } n_{s3} = 2.00$$

$$\phi_{psh,y} = \phi_{ps1,y} + \phi_{ps2,y} + \phi_{ps3,y} = 0.0010472$$

$$\phi_{ps1,y} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.0005236$$

$$h_1 = 250.00$$

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

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

$$\phi_{ps2,y} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.0005236$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

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

$$\phi_{ps3,y} (\text{web}) = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

No stirrups, ns3 = 0.00

Asec = 750000.00

s\_1 = 100.00

s\_2 = 100.00

s\_3 = 200.00

fywe = 500.00

fce = 16.00

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

c = confinement factor = 1.00

y1 = 0.00208333

sh1 = 0.00805

ft1 = 600.00

fy1 = 500.00

su1 = 0.03226667

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

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

su1 = 0.4\*esu1\_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1\_nominal = 0.08066667,

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, ASCE41-17.

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

y2 = 0.00208333

sh2 = 0.00805

ft2 = 600.00

fy2 = 500.00

su2 = 0.03226667

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

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

su2 = 0.4\*esu2\_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2\_nominal = 0.08066667,

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, ASCE41-17.

with fs2 = fs = 500.00

with Es2 = Es = 200000.00

yv = 0.00208333

shv = 0.00805

ftv = 600.00

fyv = 500.00

suv = 0.03226667

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

lo/lou,min = lb/ld = 1.00

suv = 0.4\*esuv\_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esuv\_nominal = 0.08066667,

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, ASCE41-17.

with fsv = fs = 500.00

with Esv = Es = 200000.00

1 = Asl,ten/(b\*d)\*(fs1/fc) = 0.11862785

2 = Asl,com/(b\*d)\*(fs2/fc) = 0.11862785

v = Asl,mid/(b\*d)\*(fsv/fc) = 0.00

and confined core properties:

b = 2940.00

d = 178.00

d' = 12.00

fcc (5A.2, TBDY) = 16.00

```

cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031
2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18965884
Mu = MRc (4.14) = 2.4327E+008
u = su (4.1) = 0.00019144

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

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

```

u = 0.00019712
Mu = 3.1796E+008

```

with full section properties:

```

b = 3000.00
d = 208.00
d' = 42.00
v = 0.00275581
N = 27514.027
fc = 16.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0035
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0035
we (5.4c) = 0.00
ase ((5.4d), TBDY) = (ase1*Acol1+ase2*Acol2+ase3*Aweb)/Asec = 0.00
ase1 = 0.00
sh_1 = 100.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 100.00
bo_2 = 190.00
ho_2 = 540.00
bi2_2 = 655400.00
ase3 = 0 (grid does not provide confinement)
psh,min = Min(psh,x , psh,y) = 0.0010472

```

```

psh,x = ps1,x+ps2,x+ps3,x = 0.00439823
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00125664
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00125664
h2 = 600.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,x (web) = (As3*h3/s_3)/Ac = 0.00188496
h3 = 1800.00
As3 = Astir3*ns3 = 0.00

```

No stirups, ns3 = 2.00

psh,y = ps1,y+ps2,y+ps3,y = 0.0010472  
ps1,y (column 1) = (As1\*h1/s\_1)/Ac = 0.0005236  
h1 = 250.00  
As1 = Astir1\*ns1 = 157.0796  
No stirups, ns1 = 2.00  
ps2,y (column 2) = (As2\*h2/s\_2)/Ac = 0.0005236  
h2 = 250.00  
As2 = Astir2\*ns2 = 157.0796  
No stirups, ns2 = 2.00  
ps3,y (web) = (As3\*h3/s\_3)/Ac = 0.00  
h3 = 250.00  
As3 = Astir3\*ns3 = 157.0796  
No stirups, ns3 = 0.00

Asec = 750000.00  
s\_1 = 100.00  
s\_2 = 100.00  
s\_3 = 200.00  
fywe = 500.00  
fce = 16.00

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

y1 = 0.00208333

sh1 = 0.00805

ft1 = 600.00

fy1 = 500.00

su1 = 0.03226667

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

lo/lou,min = lb/l\_d = 1.00

su1 = 0.4\*esu1\_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1\_nominal = 0.08066667,

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  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE41-17.

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

y2 = 0.00208333

sh2 = 0.00805

ft2 = 600.00

fy2 = 500.00

su2 = 0.03226667

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

lo/lou,min = lb/l\_b,min = 1.00

su2 = 0.4\*esu2\_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2\_nominal = 0.08066667,

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  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE41-17.

with fs2 = fs = 500.00

with Es2 = Es = 200000.00

yv = 0.00208333

shv = 0.00805

ftv = 600.00

fyv = 500.00

suv = 0.03226667

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

lo/lou,min = lb/l\_d = 1.00

suv = 0.4\*esuv\_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esuv\_nominal = 0.08066667,

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, ASCE41-17.

with  $f_{sv} = f_s = 500.00$

with  $E_{sv} = E_s = 200000.00$

$1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.11862785$

$2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.11862785$

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.08055366$

and confined core properties:

$b = 2940.00$

$d = 178.00$

$d' = 12.00$

$f_{cc}$  (5A.2, TBDY) = 16.00

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

$c$  = confinement factor = 1.00

$1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.14145031$

$2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.14145031$

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.09605114$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

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

--->

$su$  (4.9) = 0.2130262

$Mu = MR_c$  (4.14) = 3.1796E+008

$u = su$  (4.1) = 0.00019712

Calculation of ratio  $l_b/l_d$

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

Calculation of  $Mu_{2+}$

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

$u = 0.00019144$

$Mu = 2.4327E+008$

with full section properties:

$b = 3000.00$

$d = 208.00$

$d' = 42.00$

$v = 0.00275581$

$N = 27514.027$

$f_c = 16.00$

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

Final value of  $cu$ :  $cu^* = \text{shear\_factor} \cdot \text{Max}(cu, cc) = 0.0035$

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

From (5.4b), TBDY:  $cu = 0.0035$

$w_e$  (5.4c) = 0.00

$ase$  ((5.4d), TBDY) =  $(ase1 \cdot A_{col1} + ase2 \cdot A_{col2} + ase3 \cdot A_{web})/A_{sec} = 0.00$

$ase1 = 0.00$

$sh_1 = 100.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$ase2 = 0.00$

$sh_2 = 100.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$ase3 = 0$  (grid does not provide confinement)



$$psh,min = \text{Min}(psh,x, psh,y) = 0.0010472$$

$$psh,x = ps1,x+ps2,x+ps3,x = 0.00439823$$

$$ps1,x \text{ (column 1)} = (As1*h1/s_1)/Ac = 0.00125664$$

$$h1 = 600.00$$

$$As1 = Astir1*ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2,x \text{ (column 2)} = (As2*h2/s_2)/Ac = 0.00125664$$

$$h2 = 600.00$$

$$As2 = Astir2*ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3,x \text{ (web)} = (As3*h3/s_3)/Ac = 0.00188496$$

$$h3 = 1800.00$$

$$As3 = Astir3*ns3 = 0.00$$

$$\text{No stirups, } ns3 = 2.00$$

$$psh,y = ps1,y+ps2,y+ps3,y = 0.0010472$$

$$ps1,y \text{ (column 1)} = (As1*h1/s_1)/Ac = 0.0005236$$

$$h1 = 250.00$$

$$As1 = Astir1*ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2,y \text{ (column 2)} = (As2*h2/s_2)/Ac = 0.0005236$$

$$h2 = 250.00$$

$$As2 = Astir2*ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3,y \text{ (web)} = (As3*h3/s_3)/Ac = 0.00$$

$$h3 = 250.00$$

$$As3 = Astir3*ns3 = 157.0796$$

$$\text{No stirups, } ns3 = 0.00$$

$$Asec = 750000.00$$

$$s_1 = 100.00$$

$$s_2 = 100.00$$

$$s_3 = 200.00$$

$$fywe = 500.00$$

$$fce = 16.00$$

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

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

$$y1 = 0.00208333$$

$$sh1 = 0.00805$$

$$ft1 = 600.00$$

$$fy1 = 500.00$$

$$su1 = 0.03226667$$

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

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

$$su1 = 0.4*esu1\_nominal \text{ ((5.5), TBDY)} = 0.03226667$$

$$\text{From table 5A.1, TBDY: } esu1\_nominal = 0.08066667,$$

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

$$y1, sh1,ft1,fy1, \text{ are also multiplied by } \text{Min}(1, 1.25*(lb/l_d)^{2/3}), \text{ from 10.3.5, ASCE41-17.}$$

$$\text{with } fs1 = fs = 500.00$$

$$\text{with } Es1 = Es = 200000.00$$

$$y2 = 0.00208333$$

$$sh2 = 0.00805$$

$$ft2 = 600.00$$

$$fy2 = 500.00$$

$$su2 = 0.03226667$$

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

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

$$su2 = 0.4*esu2\_nominal \text{ ((5.5), TBDY)} = 0.03226667$$

$$\text{From table 5A.1, TBDY: } esu2\_nominal = 0.08066667,$$

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, ASCE41-17.  
 with  $fs2 = fs = 500.00$   
 with  $Es2 = Es = 200000.00$   
 $yv = 0.00208333$   
 $shv = 0.00805$   
 $ftv = 600.00$   
 $fyv = 500.00$   
 $suv = 0.03226667$   
 using (30) in Biskinis/Fardis (2013) multiplied with shear\_factor  
 and also multiplied by the shear\_factor according to 15.7.1.4, with  
 Shear\_factor = 1.00  
 $lo/lou, min = lb/ld = 1.00$   
 $suv = 0.4 \cdot esuv\_nominal ((5.5), TBDY) = 0.03226667$   
 From table 5A.1, TBDY:  $esuv\_nominal = 0.08066667$ ,  
 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, ASCE41-17.  
 with  $fsv = fs = 500.00$   
 with  $Esv = Es = 200000.00$   
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.11862785$   
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.11862785$   
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00$

and confined core properties:

$b = 2940.00$   
 $d = 178.00$   
 $d' = 12.00$   
 $fcc (5A.2, TBDY) = 16.00$   
 $cc (5A.5, TBDY) = 0.002$   
 $c = \text{confinement factor} = 1.00$   
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.14145031$   
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.14145031$   
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00$

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

---

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

---

$su (4.9) = 0.18965884$   
 $Mu = MRc (4.14) = 2.4327E+008$   
 $u = su (4.1) = 0.00019144$

Calculation of ratio  $lb/ld$

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

Calculation of  $Mu2$ -

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

$u = 0.00019712$   
 $Mu = 3.1796E+008$

with full section properties:

$b = 3000.00$   
 $d = 208.00$   
 $d' = 42.00$   
 $v = 0.00275581$   
 $N = 27514.027$   
 $fc = 16.00$   
 $co (5A.5, TBDY) = 0.002$   
 Final value of  $cu$ :  $cu^* = \text{shear\_factor} \cdot \text{Max}(cu, cc) = 0.0035$   
 The Shear\_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  $c_u = 0.0035$   
 $w_e$  (5.4c) = 0.00  
 $a_{se}$  ((5.4d), TBDY) =  $(a_{se1} \cdot A_{col1} + a_{se2} \cdot A_{col2} + a_{se3} \cdot A_{web}) / A_{sec} = 0.00$   
 $a_{se1} = 0.00$   
 $sh_1 = 100.00$   
 $bo_1 = 190.00$   
 $ho_1 = 540.00$   
 $bi2_1 = 655400.00$   
 $a_{se2} = 0.00$   
 $sh_2 = 100.00$   
 $bo_2 = 190.00$   
 $ho_2 = 540.00$   
 $bi2_2 = 655400.00$   
 $a_{se3} = 0$  (grid does not provide confinement)  
 $psh_{min} = \text{Min}(psh_x, psh_y) = 0.0010472$

$psh_x = ps1_x + ps2_x + ps3_x = 0.00439823$   
 $ps1_x$  (column 1) =  $(As1 \cdot h1 / s_1) / A_c = 0.00125664$   
 $h1 = 600.00$   
 $As1 = Astir1 \cdot ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2_x$  (column 2) =  $(As2 \cdot h2 / s_2) / A_c = 0.00125664$   
 $h2 = 600.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3_x$  (web) =  $(As3 \cdot h3 / s_3) / A_c = 0.00188496$   
 $h3 = 1800.00$   
 $As3 = Astir3 \cdot ns3 = 0.00$   
 No stirups,  $ns3 = 2.00$

$psh_y = ps1_y + ps2_y + ps3_y = 0.0010472$   
 $ps1_y$  (column 1) =  $(As1 \cdot h1 / s_1) / A_c = 0.0005236$   
 $h1 = 250.00$   
 $As1 = Astir1 \cdot ns1 = 157.0796$   
 No stirups,  $ns1 = 2.00$   
 $ps2_y$  (column 2) =  $(As2 \cdot h2 / s_2) / A_c = 0.0005236$   
 $h2 = 250.00$   
 $As2 = Astir2 \cdot ns2 = 157.0796$   
 No stirups,  $ns2 = 2.00$   
 $ps3_y$  (web) =  $(As3 \cdot h3 / s_3) / A_c = 0.00$   
 $h3 = 250.00$   
 $As3 = Astir3 \cdot ns3 = 157.0796$   
 No stirups,  $ns3 = 0.00$

$A_{sec} = 750000.00$   
 $s_1 = 100.00$   
 $s_2 = 100.00$   
 $s_3 = 200.00$

$fy_{we} = 500.00$   
 $f_{ce} = 16.00$

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

$y1 = 0.00208333$

$sh1 = 0.00805$

$ft1 = 600.00$

$fy1 = 500.00$

$su1 = 0.03226667$

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

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

$su1 = 0.4 \cdot esu1_{nominal}$  ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY:  $esu1_{nominal} = 0.08066667$ ,

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, ASCE41-17.

with  $fs1 = fs = 500.00$

```

with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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, ASCE41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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, ASCE41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785
2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785
v = Asl,mid/(b*d)*(fsv/fc) = 0.08055366
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031
2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031
v = Asl,mid/(b*d)*(fsv/fc) = 0.09605114
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.2130262
Mu = MRc (4.14) = 3.1796E+008
u = su (4.1) = 0.00019712

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 904830.218

Calculation of Shear Strength at edge 1, Vr1 = 904830.218

From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r1} = V_n < 0.83 \cdot f'_c \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$

$\mu_u/\mu_u - l_w/2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f'_c = 16.00$ , but  $f'_c \cdot 0.5 \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$\mu_u = 2.0446822E-012$

$V_u = 2.0366709E-032$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 251327.412$

$V_{s1} = 125663.706$  is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s2} = 125663.706$  is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s3} = 0.00$  is calculated for web, with:

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 400.00$

$V_{s3}$  has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

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

From (11-11), ACI 440:  $V_s + V_f \leq 1.5943E+006$

$b_w = 3000.00$

Calculation of Shear Strength at edge 2,  $V_{r2} = 904830.218$

From (22.5.1.1) and 11.5.4.3, ACI 318-14:  $V_{r2} = V_n < 0.83 \cdot f'_c \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14:  $V_c = 653502.805$

$\mu_u/\mu_u - l_w/2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f'_c = 16.00$ , but  $f'_c \cdot 0.5 \leq 8.3$  MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$\mu_u = 2.0446822E-012$

$V_u = 2.0366709E-032$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} + V_{s3} = 251327.412$

$V_{s1} = 125663.706$  is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

$V_{s2} = 125663.706$  is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 100.00$

$f_y = 400.00$

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

Vs3 = 0.00 is calculated for web, with:

d = 200.00

Av = 0.00

s = 200.00

fy = 400.00

Vs3 has been multiplied by  $2(1-s/d)$  ( $s > d/2$ , according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

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

From (11-11), ACI 440: Vs + Vf <= 1.5943E+006

bw = 3000.00

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (b)

Section Type: rcrws

Constant Properties

Knowledge Factor, = 1.00

According to 10.7.2.3, ASCE 41-17, shear walls with

transverse reinforcement percentage,  $n < 0.0015$

are considered Force-Controlled and lower-bound strengths are used according to 7.5.1.3, ASCE 41-17

$n = 0.0010472$

with  $n = ps1 + ps2 + ps3$ , being the shear reinf. ratio in a plane perpendicular to the shear axis 2

(pseudo-col.1  $ps1 = As1*b1/s1 = (As1*h1/s1) / Ac = 0.0005236$

h1 = 250.00

s1 = 100.00

total area of hoops perpendicular to shear axis, As1 = 157.0796

(pseudo-col.2  $ps2 = As2*b2/s2 = (As2*h2/s2) / Ac = 0.0005236$

h2 = 250.00

s2 = 100.00

total area of hoops perpendicular to shear axis, As2 = 157.0796

(grid  $ps3 = As3*b3/s3 = (As3*h3/s3) / Ac = 0.00$

h3 = 250.00

s3 = 200.00

total area of hoops perpendicular to shear axis, As3 = 0.00

total section area, Ac = 750000.00

Consequently:

Existing material of Primary Member: Concrete Strength,  $fc = fc\_lower\_bound = 16.00$

Existing material of Primary Member: Steel Strength,  $fs = fs\_lower\_bound = 400.00$

Concrete Elasticity,  $Ec = 21019.039$

Steel Elasticity,  $Es = 200000.00$

Total Height,  $H_{tot} = 3000.00$

Edges Width,  $W_{edg} = 250.00$

Edges Height,  $H_{edg} = 600.00$

Web Width,  $W_{web} = 250.00$

Cover Thickness,  $c = 25.00$

Element Length,  $L = 3000.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

Bending Moment,  $M = -7.7792062E-011$   
 Shear Force,  $V2 = 7.9731059E-014$   
 Shear Force,  $V3 = 31682.313$   
 Axial Force,  $F = -27619.81$   
 Longitudinal Reinforcement Area Distribution (in 2 divisions)  
     -Tension:  $As_t = 0.00$   
     -Compression:  $As_c = 6346.017$   
 Longitudinal Reinforcement Area Distribution (in 3 divisions)  
     -Tension:  $As_{ten} = 2368.761$   
     -Compression:  $As_{com} = 2368.761$   
     -Middle:  $As_{mid} = 1608.495$   
 Mean Diameter of Tension Reinforcement,  $Db_L = 17.20$

Existing component: From table 7-7, ASCE 41\_17: Final chord rotation Capacity  $u_R = u = 0.00985819$   
 $u = y + p = 0.00985819$

- Calculation of  $y$  -

$y = (M_y * I_p) / (EI)_{Eff} = 0.00185819$  ((10-5), ASCE 41-17))  
 $M_y = 2.2250E+008$   
 $(EI)_{Eff} = 0.35 * E_c * I$  (table 10-5)  
 $E_c * I = 8.2106E+013$   
 $I_p = 0.5 * d = 0.5 * (0.8 * h) = 240.00$

Calculation of Yielding Moment  $M_y$

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

$y = \text{Min}(y_{ten}, y_{com})$   
 $y_{ten} = 1.2992461E-005$   
 with  $f_y = 400.00$   
 $d = 208.00$   
 $y = 0.25992587$   
 $A = 0.01028056$   
 $B = 0.00622237$   
 with  $pt = 0.00379609$   
 $pc = 0.00379609$   
 $pv = 0.00257772$   
 $N = 27619.81$   
 $b = 3000.00$   
 $" = 0.20192308$   
 $y_{comp} = 2.5448357E-005$   
 with  $f_c = 16.00$   
 $E_c = 21019.039$   
 $y = 0.25885499$   
 $A = 0.01000838$   
 $B = 0.00611172$   
 with  $E_s = 200000.00$

Calculation of ratio  $I_b/I_d$

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

- Calculation of  $p$  -

Considering wall controlled by flexure (shear control ratio  $\leq 1$ ),  
 from table 10-19:  $p = 0.008$   
 with:

- Condition i (shear wall and wall segments)  
 -  $(A_s - A_s') \cdot f_y + P) / (t_w \cdot l_w \cdot f_c') = -0.20923225$   
 $A_s = 0.00$   
 $A_s' = 6346.017$   
 $f_y = 400.00$   
 $P = 27619.81$   
 $t_w = 3000.00$   
 $l_w = 250.00$   
 $f_c = 16.00$   
 -  $V / (t_w \cdot l_w \cdot f_c'^{0.5}) = 3.2005861E-019$ , NOTE: units in lb & in  
 - Confined Boundary: No  
 Boundary hoops spacing does not exceed  $8d_b$  ( $s_1 < 8 \cdot d_b$  and  $s_2 < 8 \cdot d_b$ )  
 Boundary Trans. Reinf. does not exceed 50% of ACI 318 provision ( $V_{w1} + V_{w2} > 0.50 \cdot (V - V_c - V_{w3})$ )  
 With  
 Boundary Element 1:  
 $V_{w1} = 125663.706$   
 $s_1 = 100.00$   
 Boundary Element 2:  
 $V_{w2} = 125663.706$   
 $s_2 = 100.00$   
 Grid Shear Force,  $V_{w3} = 0.00$   
 Concrete Shear Force,  $V_c = 191830.46$   
 (The variables above have already been given in Shear control ratio calculation)  
 Mean diameter of all bars,  $d_b = 17.33333$   
 Design Shear Force,  $V = 7.9731059E-014$

-----  
 End Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1  
 At local axis: 3  
 Integration Section: (b)  
 -----