

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 VR_d
- 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, ASCE 41-17.
- Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
- Consequently:
- New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$
- New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$
- Concrete Elasticity, $E_c = 25742.96$

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
 Smooth Bars
 Ductile Steel
 With Detailing for Earthquake Resistance (including stirrups closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $l_o = l_b = 300.00$
 No FRP Wrapping

Stepwise Properties

EDGE -A-
 Bending Moment, $M_a = 4.0958227E-010$
 Shear Force, $V_a = 1.8122959E-014$
 EDGE -B-
 Bending Moment, $M_b = -3.5014360E-010$
 Shear Force, $V_b = -1.8122959E-014$
 BOTH EDGES
 Axial Force, $F = -29697.588$
 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, $Db_{L,ten} = 17.20$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 241921.403$
 From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d = 241921.403$

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: $V_c = 137201.648$
 $M_u/V_u - l_w/2 = 22475.187 > 0$
 = 1 (normal-weight concrete)
 $f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 3000.00$
 $d = 200.00$
 $l_w = 250.00$
 $M_u = 4.0958227E-010$
 $V_u = 1.8122959E-014$
 $N_u = 29697.588$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 104719.755$
 $V_{s1} = 52359.878$ is calculated for pseudo-Column 1, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 500.00$
 V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17, 10.3.4)
 $2(1-s/d) = 0.50$
 $V_{s2} = 52359.878$ is calculated for pseudo-Column 2, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 500.00$

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

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

Vs3 = 0.00 is calculated for web, with:

$$d = 200.00$$

$$A_v = 0.00$$

$$s = 200.00$$

$$f_y = 500.00$$

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

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

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

$$\text{From } (11-11), \text{ACI 440: } V_s + V_f \leq 1.7825\text{E}+006$$

$$b_w = 3000.00$$

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

At local axis: 2

Integration Section: (a)

Calculation No. 2

wall W1, Floor 1

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

Analysis: Uniform +X

Check: Chord rotation capacity (μ)

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, $\gamma = 1.00$

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

Consequently:

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

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 500.00$
Concrete Elasticity, $E_c = 25742.96$
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
New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 625.00$

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
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_o = 300.00$
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, $V_a = 2.0194839E-028$
EDGE -B-
Shear Force, $V_b = -2.0194839E-028$
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 , $V_e/V_r = 0.68720049$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 1.2357E+006$
with
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 1.8535E+009$
 $\mu_{u1+} = 1.7546E+009$, 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
 $\mu_{u1-} = 1.8535E+009$, 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
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 1.8535E+009$
 $\mu_{u2+} = 1.7546E+009$, 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
 $\mu_{u2-} = 1.8535E+009$, 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 μ_{u1+}

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:
 $\mu = 1.1650088E-006$

$$\mu = 1.7546E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00186094$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

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

The Shear_factor is considered equal to 1 (pure moment strength)

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

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

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

$$\phi_{se1} = 0.00$$

$$s_{h1} = 150.00$$

$$b_{o1} = 190.00$$

$$h_{o1} = 540.00$$

$$b_{i2,1} = 655400.00$$

$$\phi_{se2} = 0.00$$

$$s_{h2} = 150.00$$

$$b_{o2} = 190.00$$

$$h_{o2} = 540.00$$

$$b_{i2,2} = 655400.00$$

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

$$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00069813$$

$$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00356047$$

$$\phi_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

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

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

$$\phi_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

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

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

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

$$h_3 = 1800.00$$

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

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

$$\phi_{sh,y} = \phi_{s1,y} + \phi_{s2,y} + \phi_{s3,y} = 0.00069813$$

$$\phi_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

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

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

$$\phi_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

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

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

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

$$h_3 = 250.00$$

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

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

$$A_{sec} = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 625.00$$

$$f_{ce} = 20.00$$

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

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

$$y_1 = 0.00084854$$

$$s_{h1} = 0.00271532$$

$$f_{t1} = 254.5614$$

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fy1 = 212.1345
su1 = 0.00271532
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.14149197
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs1 = fs = 212.1345
    with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.14149197
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = fs = 212.1345
    with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.14149197
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = fs = 212.1345
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04110878
2 = Asl,com/(b*d)*(fs2/fc) = 0.04110878
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) = 20.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.0546449
    2 = Asl,com/(b*d)*(fs2/fc) = 0.0546449
    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) = 0.21179234
Mu = MRc (4.14) = 1.7546E+009
u = su (4.1) = 1.1650088E-006

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Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$

$l_b = 300.00$

$l_d = 2120.262$

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

l_d ,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$= 1$

$db = 16.85714$

Mean strength value of all re-bars: $f_y = 625.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of μ_1 -

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

$\mu = 1.1680845E-006$

$\mu_u = 1.8535E+009$

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$

$v = 0.00186094$

$N = 27514.027$

$f_c = 20.00$

ϕ_c (5A.5, TBDY) = 0.002

Final value of ϕ_c : $\phi_c^* = \text{shear_factor} * \text{Max}(\phi_c, \phi_{cc}) = 0.0035$

The Shear_factor is considered equal to 1 (pure moment strength)

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

ϕ_{cc} (5.4c) = 0.00

ϕ_{cc} ((5.4d), TBDY) = $(\phi_{cc1} * A_{col1} + \phi_{cc2} * A_{col2} + \phi_{cc3} * A_{web}) / A_{sec} = 0.00$

$\phi_{cc1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$\phi_{cc2} = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$\phi_{cc3} = 0$ (grid does not provide confinement)

$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00069813$

$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00356047$

$\phi_{s1,x}$ (column 1) = $(A_{s1} * h_1 / s_1) / A_c = 0.00083776$

$h_1 = 600.00$

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

No stirups, $n_{s1} = 2.00$

$\phi_{s2,x}$ (column 2) = $(A_{s2} * h_2 / s_2) / A_c = 0.00083776$

$h_2 = 600.00$

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

No stirups, $n_{s2} = 2.00$

$\phi_{s3,x}$ (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, ns3 = 2.00

psh,y = ps1,y+ps2,y+ps3,y = 0.00069813

ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907

h1 = 250.00

As1 = Astir1*ns1 = 157.0796

No stirups, ns1 = 2.00

ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907

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 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 625.00

fce = 20.00

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

c = confinement factor = 1.00

y1 = 0.00084854

sh1 = 0.00271532

ft1 = 254.5614

fy1 = 212.1345

su1 = 0.00271532

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

lo/lou,min = lb/ld = 0.14149197

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

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

with fs1 = fs = 212.1345

with Es1 = Es = 200000.00

y2 = 0.00084854

sh2 = 0.00271532

ft2 = 254.5614

fy2 = 212.1345

su2 = 0.00271532

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

lo/lou,min = lb/lb,min = 0.14149197

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

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

with fs2 = fs = 212.1345

with Es2 = Es = 200000.00

yv = 0.00084854

shv = 0.00271532

ftv = 254.5614

fyv = 212.1345

suv = 0.00271532

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

lo/lou,min = lb/ld = 0.14149197

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY
For calculation of $e_{sv_nominal}$ and y_v , sh_v , ft_v , f_{yv} , it is considered
characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.

y_1 , sh_1 , ft_1 , f_{y1} , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $f_{sv} = f_s = 212.1345$

with $E_{sv} = E_s = 200000.00$

$1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.04110878$

$2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.04110878$

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00883478$

and confined core properties:

$b = 190.00$

$d = 2927.00$

$d' = 13.00$

f_{cc} (5A.2, TBDY) = 20.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

$1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.0546449$

$2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.0546449$

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.01174386$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.21386777

$\mu_u = M_{Rc}$ (4.14) = 1.8535E+009

$u = su$ (4.1) = 1.1680845E-006

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$

$l_b = 300.00$

$l_d = 2120.262$

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

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$db = 16.85714$

Mean strength value of all re-bars: $f_y = 625.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of μ_{u2+}

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

$u = 1.1650088E-006$

$\mu_u = 1.7546E+009$

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$

$v = 0.00186094$

$N = 27514.027$

$f_c = 20.00$

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: $cu = 0.0035$

```

we (5.4c) = 0.00
ase ((5.4d), TBDY) = (ase1*Acol1+ase2*Acol2+ase3*Aweb)/Asec = 0.00
ase1 = 0.00
sh_1 = 150.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 150.00
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) = 0.00069813

```

```

psh,x = ps1,x+ps2,x+ps3,x = 0.00356047
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00083776
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776
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 = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
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 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 625.00
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00084854
sh1 = 0.00271532
ft1 = 254.5614
fy1 = 212.1345
su1 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/l_d = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/l_d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00

```

```

y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 212.1345
with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04110878
2 = Asl,com/(b*d)*(fs2/fc) = 0.04110878
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) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0546449
2 = Asl,com/(b*d)*(fs2/fc) = 0.0546449
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) = 0.21179234
Mu = MRc (4.14) = 1.7546E+009
u = su (4.1) = 1.1650088E-006

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.14149197
lb = 300.00
ld = 2120.262
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 625.00
t = 1.00

```

s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

Calculation of Mu2-

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

$u = 1.1680845E-006$

$Mu = 1.8535E+009$

with full section properties:

b = 250.00
d = 2957.00
d' = 43.00
v = 0.00186094
N = 27514.027

fc = 20.00

co (5A.5, TBDY) = 0.002

Final value of ϕ_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: $\phi_u = 0.0035$

we (5.4c) = 0.00

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

ase1 = 0.00

sh_1 = 150.00

bo_1 = 190.00

ho_1 = 540.00

bi2_1 = 655400.00

ase2 = 0.00

sh_2 = 150.00

bo_2 = 190.00

ho_2 = 540.00

bi2_2 = 655400.00

ase3 = 0 (grid does not provide confinement)

psh,min = $\text{Min}(psh,x, psh,y) = 0.00069813$

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$

$ps1,x$ (column 1) = $(As1 * h1 / s_1) / A_c = 0.00083776$

h1 = 600.00

$As1 = Astir1 * ns1 = 157.0796$

No stirups, ns1 = 2.00

$ps2,x$ (column 2) = $(As2 * h2 / s_2) / A_c = 0.00083776$

h2 = 600.00

$As2 = Astir2 * ns2 = 157.0796$

No stirups, ns2 = 2.00

$ps3,x$ (web) = $(As3 * h3 / s_3) / A_c = 0.00188496$

h3 = 1800.00

$As3 = Astir3 * ns3 = 0.00$

No stirups, ns3 = 2.00

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$

$ps1,y$ (column 1) = $(As1 * h1 / s_1) / A_c = 0.00034907$

h1 = 250.00

$As1 = Astir1 * ns1 = 157.0796$

No stirups, ns1 = 2.00

$ps2,y$ (column 2) = $(As2 * h2 / s_2) / A_c = 0.00034907$

h2 = 250.00

$As2 = Astir2 * ns2 = 157.0796$

No stirups, ns2 = 2.00

$ps3,y$ (web) = $(As3 * h3 / s_3) / A_c = 0.00$

h3 = 250.00

As3 = Astir3*ns3 = 157.0796
No stirups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 625.00

fce = 20.00

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

c = confinement factor = 1.00

y1 = 0.00084854

sh1 = 0.00271532

ft1 = 254.5614

fy1 = 212.1345

su1 = 0.00271532

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

lo/lou,min = lb/ld = 0.14149197

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

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

with fs1 = fs = 212.1345

with Es1 = Es = 200000.00

y2 = 0.00084854

sh2 = 0.00271532

ft2 = 254.5614

fy2 = 212.1345

su2 = 0.00271532

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

lo/lou,min = lb/lb,min = 0.14149197

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

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

with fs2 = fs = 212.1345

with Es2 = Es = 200000.00

yv = 0.00084854

shv = 0.00271532

ftv = 254.5614

fyv = 212.1345

suv = 0.00271532

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

lo/lou,min = lb/ld = 0.14149197

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

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

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

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

with fsv = fs = 212.1345

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.04110878

2 = Asl,com/(b*d)*(fs2/fc) = 0.04110878

v = Asl,mid/(b*d)*(fsv/fc) = 0.00883478

and confined core properties:

b = 190.00

d = 2927.00

d' = 13.00

f_{cc} (5A.2, TBDY) = 20.00
 cc (5A.5, TBDY) = 0.002
 c = confinement factor = 1.00
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.0546449$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.0546449$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.01174386$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 su (4.9) = 0.21386777
 $Mu = MRc$ (4.14) = 1.8535E+009
 $u = su$ (4.1) = 1.1680845E-006

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$
 $l_b = 300.00$
 $l_d = 2120.262$
 Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $f_y = 625.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 1.7981E+006$

Calculation of Shear Strength at edge 1, $V_{r1} = 1.7981E+006$
 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: $V_c = 729988.83$
 $Mu/V_u - l_w/2 = 0.00 \leq 0$
 $= 1$ (normal-weight concrete)
 $f'_c = 20.00$, but $f'_c*0.5 \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 250.00$
 $d = 2400.00$
 $l_w = 3000.00$
 $Mu = 1.6689249E-009$
 $V_u = 2.0194839E-028$
 $Nu = 27514.027$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0681E+006$
 $V_{s1} = 251327.412$ is calculated for pseudo-Column 1, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 500.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 251327.412$ is calculated for pseudo-Column 2, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 500.00$
 V_{s2} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs3 = 565486.678 is calculated for web, with:

d = 1440.00

Av = 157079.633

s = 200.00

fy = 500.00

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 <= 1.7825E+006

bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 1.7981E+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 = 729988.83

Mu/Vu-lw/2 = 0.00 <= 0

= 1 (normal-weight concrete)

fc' = 20.00, but $fc'^{0.5} <= 8.3$ MPa (22.5.3.1, ACI 318-14)

h = 250.00

d = 2400.00

lw = 3000.00

Mu = 1.6689249E-009

Vu = 2.0194839E-028

Nu = 27514.027

From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 + Vs3 = 1.0681E+006

Vs1 = 251327.412 is calculated for pseudo-Column 1, with:

d = 480.00

Av = 157079.633

s = 150.00

fy = 500.00

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

Vs2 = 251327.412 is calculated for pseudo-Column 2, with:

d = 480.00

Av = 157079.633

s = 150.00

fy = 500.00

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

Vs3 = 565486.678 is calculated for web, with:

d = 1440.00

Av = 157079.633

s = 200.00

fy = 500.00

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 <= 1.7825E+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, = 1.00

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

Consequently:

New material of Primary Member: Concrete Strength, fc = fcm = 20.00

New material of Primary Member: Steel Strength, fs = fsm = 500.00

Concrete Elasticity, $E_c = 25742.96$
 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
 New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 625.00$
 #####
 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
 Smooth Bars
 Ductile Steel
 With Detailing for Earthquake Resistance (including stirrups closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $l_o = 300.00$
 No FRP Wrapping

Stepwise Properties

At local axis: 2
 EDGE -A-
 Shear Force, $V_a = -4.7331654E-030$
 EDGE -B-
 Shear Force, $V_b = 4.7331654E-030$
 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: $A_{sl,ten} = 2368.761$
 -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, $V_e/V_r = 0.08592175$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 71719.625$
 with
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 1.0758E+008$
 $\mu_{u1+} = 8.8591E+007$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
 which is defined for the static loading combination
 $\mu_{u1-} = 1.0758E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment
 direction which is defined for the static loading combination
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 1.0758E+008$
 $\mu_{u2+} = 8.8591E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
 which is defined for the the static loading combination
 $\mu_{u2-} = 1.0758E+008$, 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 μ_{u1+}

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:
 $\mu = 1.7029732E-005$
 $\mu_u = 8.8591E+007$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00220465$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

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

The Shear_factor is considered equal to 1 (pure moment strength)

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

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

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

$$\phi_{se1} = 0.00$$

$$s_{h1} = 150.00$$

$$b_{o1} = 190.00$$

$$h_{o1} = 540.00$$

$$b_{i2,1} = 655400.00$$

$$\phi_{se2} = 0.00$$

$$s_{h2} = 150.00$$

$$b_{o2} = 190.00$$

$$h_{o2} = 540.00$$

$$b_{i2,2} = 655400.00$$

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

$$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00069813$$

$$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00356047$$

$$\phi_{s1,x} (\text{column 1}) = (A_{s1} * h_1 / s_{h1}) / A_c = 0.00083776$$

$$h_1 = 600.00$$

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

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

$$\phi_{s2,x} (\text{column 2}) = (A_{s2} * h_2 / s_{h2}) / A_c = 0.00083776$$

$$h_2 = 600.00$$

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

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

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

$$h_3 = 1800.00$$

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

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

$$\phi_{sh,y} = \phi_{s1,y} + \phi_{s2,y} + \phi_{s3,y} = 0.00069813$$

$$\phi_{s1,y} (\text{column 1}) = (A_{s1} * h_1 / s_{h1}) / A_c = 0.00034907$$

$$h_1 = 250.00$$

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

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

$$\phi_{s2,y} (\text{column 2}) = (A_{s2} * h_2 / s_{h2}) / A_c = 0.00034907$$

$$h_2 = 250.00$$

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

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

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

$$h_3 = 250.00$$

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

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

$$A_{sec} = 750000.00$$

$$s_{h1} = 150.00$$

$$s_{h2} = 150.00$$

$$s_{h3} = 200.00$$

$$f_{ywe} = 625.00$$

$$f_{ce} = 20.00$$

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

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

$$y_1 = 0.00084854$$

$$s_{h1} = 0.00271532$$

$$f_{t1} = 254.5614$$

$$f_{y1} = 212.1345$$

```

su1 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb,min)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb,min)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 212.1345
with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb,min)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04026409
2 = Asl,com/(b*d)*(fs2/fc) = 0.04026409
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) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04801038
2 = Asl,com/(b*d)*(fs2/fc) = 0.04801038
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) = 0.23343312
Mu = MRc (4.14) = 8.8591E+007
u = su (4.1) = 1.7029732E-005

```

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$

$l_b = 300.00$

$l_d = 2120.262$

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

l_d, \min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$= 1$

$db = 16.85714$

Mean strength value of all re-bars: $f_y = 625.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of μ_1 -

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

$\mu = 1.7245646E-005$

$\mu_u = 1.0758E+008$

with full section properties:

$b = 3000.00$

$d = 208.00$

$d' = 42.00$

$v = 0.00220465$

$N = 27514.027$

$f_c = 20.00$

α_0 (5A.5, TBDY) = 0.002

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.0035$

The Shear_factor is considered equal to 1 (pure moment strength)

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

μ_{ue} (5.4c) = 0.00

μ_{ue} ((5.4d), TBDY) = $(\mu_{ue1} * A_{col1} + \mu_{ue2} * A_{col2} + \mu_{ue3} * A_{web}) / A_{sec} = 0.00$

$\mu_{ue1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$\mu_{ue2} = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$\mu_{ue3} = 0$ (grid does not provide confinement)

$\mu_{psh, \min} = \text{Min}(\mu_{psh, x}, \mu_{psh, y}) = 0.00069813$

$\mu_{psh, x} = \mu_{psh, x1} + \mu_{psh, x2} + \mu_{psh, x3} = 0.00356047$

$\mu_{psh, x1}$ (column 1) = $(A_{s1} * h_1 / s_1) / A_c = 0.00083776$

$h_1 = 600.00$

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

No stirups, $n_{s1} = 2.00$

$\mu_{psh, x2}$ (column 2) = $(A_{s2} * h_2 / s_2) / A_c = 0.00083776$

$h_2 = 600.00$

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

No stirups, $n_{s2} = 2.00$

$\mu_{psh, x3}$ (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 = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
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 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 625.00
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00084854
sh1 = 0.00271532
ft1 = 254.5614
fy1 = 212.1345
su1 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 212.1345
with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

```

For calculation of $\epsilon_{sv_nominal}$ and γ_v , Δv , Δf_v , f_{yv} , it is considered characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.

γ_1 , Δf_1 , f_{y1} , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $f_{sv} = f_s = 212.1345$

with $E_{sv} = E_s = 200000.00$

$1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.04026409$

$2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.04026409$

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.02734113$

and confined core properties:

$b = 2940.00$

$d = 178.00$

$d' = 12.00$

f_{cc} (5A.2, TBDY) = 20.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

$1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.04801038$

$2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.04801038$

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.03260121$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

μ_u (4.9) = 0.24303049

$\mu_u = M_{Rc}$ (4.14) = 1.0758E+008

$u = \mu_u$ (4.1) = 1.7245646E-005

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$

$l_b = 300.00$

$l_d = 2120.262$

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

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$d_b = 16.85714$

Mean strength value of all re-bars: $f_y = 625.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$c_b = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of μ_{u2+}

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

$u = 1.7029732E-005$

$\mu_u = 8.8591E+007$

with full section properties:

$b = 3000.00$

$d = 208.00$

$d' = 42.00$

$v = 0.00220465$

$N = 27514.027$

$f_c = 20.00$

cc (5A.5, TBDY) = 0.002

Final value of μ_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: $\mu_u = 0.0035$

μ_u (5.4c) = 0.00

$$ase((5.4d), TBDY) = (ase1 \cdot Acol1 + ase2 \cdot Acol2 + ase3 \cdot Aweb) / Asec = 0.00$$

$$ase1 = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$ase2 = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

$$psh,min = \text{Min}(psh,x, psh,y) = 0.00069813$$

$$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$$

$$ps1,x \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00083776$$

$$h1 = 600.00$$

$$As1 = Astir1 \cdot ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2,x \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00083776$$

$$h2 = 600.00$$

$$As2 = Astir2 \cdot ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3,x \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00188496$$

$$h3 = 1800.00$$

$$As3 = Astir3 \cdot ns3 = 0.00$$

$$\text{No stirups, } ns3 = 2.00$$

$$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$$

$$ps1,y \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00034907$$

$$h1 = 250.00$$

$$As1 = Astir1 \cdot ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00034907$$

$$h2 = 250.00$$

$$As2 = Astir2 \cdot ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

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

$$h3 = 250.00$$

$$As3 = Astir3 \cdot ns3 = 157.0796$$

$$\text{No stirups, } ns3 = 0.00$$

$$Asec = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$fywe = 625.00$$

$$fce = 20.00$$

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

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

$$y1 = 0.00084854$$

$$sh1 = 0.00271532$$

$$ft1 = 254.5614$$

$$fy1 = 212.1345$$

$$su1 = 0.00271532$$

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

$$lo/lou,min = lb/ld = 0.14149197$$

$$su1 = 0.4 \cdot esu1_nominal((5.5), TBDY) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu1_nominal = 0.08,$$

For calculation of esu1_nominal and y1, sh1, ft1, fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

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

$$\text{with } fs1 = fs = 212.1345$$

$$\text{with } Es1 = Es = 200000.00$$

$$y2 = 0.00084854$$

```

sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb,min = 0.14149197
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = fs = 212.1345
    with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/ld = 0.14149197
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = fs = 212.1345
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04026409
2 = Asl,com/(b*d)*(fs2/fc) = 0.04026409
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) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04801038
2 = Asl,com/(b*d)*(fs2/fc) = 0.04801038
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) = 0.23343312
Mu = MRc (4.14) = 8.8591E+007
u = su (4.1) = 1.7029732E-005

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.14149197
lb = 300.00
ld = 2120.262
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 625.00
t = 1.00
s = 0.80

```

e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

Calculation of Mu2-

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

$\phi_u = 1.7245646E-005$
 $M_u = 1.0758E+008$

with full section properties:

b = 3000.00
d = 208.00
d' = 42.00
v = 0.00220465
N = 27514.027

fc = 20.00
co (5A.5, TBDY) = 0.002

Final value of ϕ_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: $\phi_u = 0.0035$

we (5.4c) = 0.00

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

ase1 = 0.00

sh_1 = 150.00

bo_1 = 190.00

ho_1 = 540.00

bi2_1 = 655400.00

ase2 = 0.00

sh_2 = 150.00

bo_2 = 190.00

ho_2 = 540.00

bi2_2 = 655400.00

ase3 = 0 (grid does not provide confinement)

psh,min = $\text{Min}(psh,x, psh,y) = 0.00069813$

psh,x = $ps1,x + ps2,x + ps3,x = 0.00356047$

ps1,x (column 1) = $(As1 * h1 / s_1) / A_c = 0.00083776$

h1 = 600.00

As1 = $A_{stir1} * n_{s1} = 157.0796$

No stirups, ns1 = 2.00

ps2,x (column 2) = $(As2 * h2 / s_2) / A_c = 0.00083776$

h2 = 600.00

As2 = $A_{stir2} * n_{s2} = 157.0796$

No stirups, ns2 = 2.00

ps3,x (web) = $(As3 * h3 / s_3) / A_c = 0.00188496$

h3 = 1800.00

As3 = $A_{stir3} * n_{s3} = 0.00$

No stirups, ns3 = 2.00

psh,y = $ps1,y + ps2,y + ps3,y = 0.00069813$

ps1,y (column 1) = $(As1 * h1 / s_1) / A_c = 0.00034907$

h1 = 250.00

As1 = $A_{stir1} * n_{s1} = 157.0796$

No stirups, ns1 = 2.00

ps2,y (column 2) = $(As2 * h2 / s_2) / A_c = 0.00034907$

h2 = 250.00

As2 = $A_{stir2} * n_{s2} = 157.0796$

No stirups, ns2 = 2.00

ps3,y (web) = $(As3 * h3 / s_3) / A_c = 0.00$

h3 = 250.00

As3 = $A_{stir3} * n_{s3} = 157.0796$

No stirrups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 625.00

fce = 20.00

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

c = confinement factor = 1.00

y1 = 0.00084854

sh1 = 0.00271532

ft1 = 254.5614

fy1 = 212.1345

su1 = 0.00271532

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

lo/lou,min = lb/lb = 0.14149197

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

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

with fs1 = fs = 212.1345

with Es1 = Es = 200000.00

y2 = 0.00084854

sh2 = 0.00271532

ft2 = 254.5614

fy2 = 212.1345

su2 = 0.00271532

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

lo/lou,min = lb/lb,min = 0.14149197

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

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

with fs2 = fs = 212.1345

with Es2 = Es = 200000.00

yv = 0.00084854

shv = 0.00271532

ftv = 254.5614

fyv = 212.1345

suv = 0.00271532

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

lo/lou,min = lb/lb = 0.14149197

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

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

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

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

with fsv = fs = 212.1345

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.04026409

2 = Asl,com/(b*d)*(fs2/fc) = 0.04026409

v = Asl,mid/(b*d)*(fsv/fc) = 0.02734113

and confined core properties:

b = 2940.00

d = 178.00

d' = 12.00

fcc (5A.2, TBDY) = 20.00

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

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

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.04801038$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.04801038$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.03260121$$

Case/Assumption: Unconfined full section - Steel rupture

'satisfies Eq. (4.3)

--->

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

--->

$$su(4.9) = 0.24303049$$

$$Mu = MRc(4.14) = 1.0758E+008$$

$$u = su(4.1) = 1.7245646E-005$$

Calculation of ratio l_b/l_d

$$\text{Lap Length: } l_b/l_d = 0.14149197$$

$$l_b = 300.00$$

$$l_d = 2120.262$$

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

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 16.85714$$

Mean strength value of all re-bars: $f_y = 625.00$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 834708.585$

Calculation of Shear Strength at edge 1, $V_{r1} = 834708.585$

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: $V_c = 729988.83$

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

= 1 (normal-weight concrete)

$$f_c' = 20.00, \text{ but } f_c'^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$h = 3000.00$$

$$d = 200.00$$

$$l_w = 250.00$$

$$Mu = 3.9108324E-011$$

$$V_u = 4.7331654E-030$$

$$Nu = 27514.027$$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 104719.755$

$V_{s1} = 52359.878$ is calculated for pseudo-Column 1, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 500.00$$

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

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

$V_{s2} = 52359.878$ is calculated for pseudo-Column 2, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 500.00$$

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

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

Vs3 = 0.00 is calculated for web, with:

$$d = 200.00$$

$$A_v = 0.00$$

$$s = 200.00$$

$$f_y = 500.00$$

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: $V_s + V_f \leq 1.7825E+006$

$$b_w = 3000.00$$

Calculation of Shear Strength at edge 2, $V_{r2} = 834708.585$

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: $V_c = 729988.83$

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

= 1 (normal-weight concrete)

$$f_c' = 20.00, \text{ but } f_c' \cdot 0.5 \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$h = 3000.00$$

$$d = 200.00$$

$$l_w = 250.00$$

$$\mu_u = 3.9108324E-011$$

$$V_u = 4.7331654E-030$$

$$N_u = 27514.027$$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 104719.755$

$V_{s1} = 52359.878$ is calculated for pseudo-Column 1, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 500.00$$

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

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

$V_{s2} = 52359.878$ is calculated for pseudo-Column 2, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 500.00$$

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

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

Vs3 = 0.00 is calculated for web, with:

$$d = 200.00$$

$$A_v = 0.00$$

$$s = 200.00$$

$$f_y = 500.00$$

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: $V_s + V_f \leq 1.7825E+006$

$$b_w = 3000.00$$

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: rcwrs

Constant Properties

Knowledge Factor, $\phi = 1.00$
 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
 $n = 0.00069813$

with $n = ps1 + ps2 + ps3$, being the shear reinf. ratio in a plane perpendicular to the shear axis 3
 (pseudo-col.1 $ps1 = As1*b1/s1 = (As1*h1/s1) / Ac = 0.00034907$
 $h1 = 250.00$
 $s1 = 150.00$
 total area of hoops perpendicular to shear axis, $As1 = 157.0796$
 (pseudo-col.2 $ps2 = As2*b2/s2 = (As2*h2/s2) / Ac = 0.00034907$
 $h2 = 250.00$
 $s2 = 150.00$
 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:
 New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$
 New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$
 Concrete Elasticity, $E_c = 25742.96$
 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
 Smooth Bars
 Ductile Steel
 With Detailing for Earthquake Resistance (including stirrups closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $l_b = 300.00$
 No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 5.6994E+007$
 Shear Force, $V2 = 1.8122959E-014$
 Shear Force, $V3 = -19169.48$
 Axial Force, $F = -29697.588$
 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: $As_{l,ten} = 2865.133$
 -Compression: $As_{l,com} = 2865.133$
 -Middle: $As_{l,mid} = 615.7522$
 Mean Diameter of Tension Reinforcement, $DbL = 17.33333$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.00240492$
 $u = y + p = 0.00240492$

- Calculation of y -

$y = (M_y * I_p) / (EI)_{Eff} = 0.00040492$ ((10-5), ASCE 41-17))
 $M_y = 1.7102E+009$

(EI)Eff = 0.35*Ec*I (table 10-5)
Ec*I = 1.4480E+016
Ip = 0.5*d = 0.5*(0.8*h) = 1200.00

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

$y = \text{Min}(y_{\text{ten}}, y_{\text{com}})$
 $y_{\text{ten}} = 4.1963465\text{E-}007$
with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25*f_y*(l_b/d)^{2/3}) = 196.9282$
 $d = 2957.00$
 $y = 0.20648484$
 $A = 0.0087884$
 $B = 0.00455861$
with $p_t = 0.00387573$
 $p_c = 0.00387573$
 $p_v = 0.00083294$
 $N = 29697.588$
 $b = 250.00$
 $" = 0.01454177$
 $y_{\text{comp}} = 2.3333296\text{E-}006$
with $f_c = 20.00$
 $E_c = 25742.96$
 $y = 0.20268266$
 $A = 0.00844077$
 $B = 0.00435462$
with $E_s = 200000.00$

Calculation of ratio l_b/d

Lap Length: $l_d/l_{d,\text{min}} = 0.17686496$
 $l_b = 300.00$
 $l_d = 1696.209$
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,\text{min}}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
 $= 1$
 $db = 16.85714$
Mean strength value of all re-bars: $f_y = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

- Calculation of p -

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

with:

- Condition i (shear wall and wall segments)
- $(A_s - A_s')*f_y + P)/(t_w*l_w*f_c') = -0.20955407$
 $A_s = 0.00$
 $A_s' = 6346.017$
 $f_y = 500.00$
 $P = 29697.588$
 $t_w = 250.00$
 $l_w = 3000.00$
 $f_c = 20.00$
- $V/(t_w*l_w*f_c'^{0.5}) = 0.06882676$, NOTE: units in lb & in
- Confined Boundary: No

Boundary hoops spacing exceed $8d_b$ ($s_1 > 8 \cdot d_b$ or $s_2 > 8 \cdot d_b$)

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:

$$V_{w1} = 251327.412$$

$$s_1 = 150.00$$

Boundary Element 2:

$$V_{w2} = 251327.412$$

$$s_2 = 150.00$$

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

Concrete Shear Force, $V_c = 690272.24$

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

Mean diameter of all bars, $d_b = 17.33333$

Design Shear Force, $V = 19169.48$

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 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: rcwvs

Constant Properties

Knowledge Factor, $\phi = 1.00$
 Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
 Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
 Consequently:
 New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$
 New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$
 Concrete Elasticity, $E_c = 25742.96$
 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
 Smooth Bars
 Ductile Steel
 With Detailing for Earthquake Resistance (including stirrups closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $l_o = l_b = 300.00$
 No FRP Wrapping

Stepwise Properties

EDGE -A-
 Bending Moment, $M_a = 5.6994E+007$
 Shear Force, $V_a = -19169.48$
 EDGE -B-
 Bending Moment, $M_b = 525745.339$
 Shear Force, $V_b = 19169.48$
 BOTH EDGES
 Axial Force, $F = -29697.588$
 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, $Db_{L,ten} = 17.33333$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 1.7584E+006$
 From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c^{0.5} \cdot h \cdot d = 1.7584E+006$

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: $V_c = 690272.24$
 $M_u/V_u - l_w/2 = 1473.165 > 0$
 $= 1$ (normal-weight concrete)
 $f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 250.00$
 $d = 2400.00$
 $l_w = 3000.00$
 $M_u = 5.6994E+007$
 $V_u = 19169.48$
 $N_u = 29697.588$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0681E+006$
 $V_{s1} = 251327.412$ is calculated for pseudo-Column 1, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$

$f_y = 500.00$

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

Vs2 = 251327.412 is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

Vs3 = 565486.678 is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 500.00$

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: $V_s + V_f \leq 1.7825E+006$

$b_w = 250.00$

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

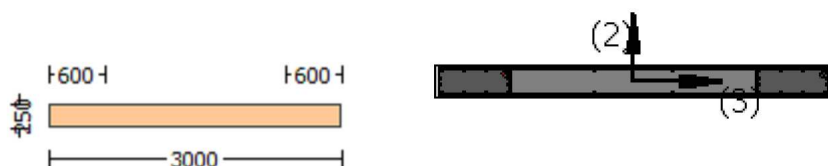
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (μ)

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:
 New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 20.00$
 New material of Primary Member: Steel Strength, $f_s = f_{sm} = 500.00$
 Concrete Elasticity, $E_c = 25742.96$
 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
 New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 625.00$
 #####
 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
 Smooth Bars
 Ductile Steel
 With Detailing for Earthquake Resistance (including stirrups closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $l_o = 300.00$
 No FRP Wrapping

Stepwise Properties

At local axis: 3
 EDGE -A-
 Shear Force, $V_a = 2.0194839E-028$
 EDGE -B-
 Shear Force, $V_b = -2.0194839E-028$
 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: $As_{l,mid} = 0.00$
 (According to 10.7.2.3 $As_{l,mid}$ is set equal to zero)

Calculation of Shear Capacity ratio, $V_e/V_r = 0.68720049$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 1.2357E+006$
 with
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 1.8535E+009$
 $\mu_{u1+} = 1.7546E+009$, 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
 $\mu_{u1-} = 1.8535E+009$, 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
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 1.8535E+009$
 $\mu_{u2+} = 1.7546E+009$, 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
 $\mu_{u2-} = 1.8535E+009$, 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 μ_{u1+}

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

$$\phi_u = 1.1650088E-006$$

$$\mu = 1.7546E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$\nu = 0.00186094$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

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

The Shear_factor is considered equal to 1 (pure moment strength)

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

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

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

$$\alpha_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$\alpha_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

$$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00069813$$

$$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00356047$$

$$\phi_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

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

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

$$\phi_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

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

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

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

$$h_3 = 1800.00$$

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

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

$$\phi_{sh,y} = \phi_{s1,y} + \phi_{s2,y} + \phi_{s3,y} = 0.00069813$$

$$\phi_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

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

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

$$\phi_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

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

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

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

$$h_3 = 250.00$$

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

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

$$A_{sec} = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 625.00$$

$$f_{ce} = 20.00$$

```

From ((5.A.5), TBDY), TBDY:  $cc = 0.002$ 
 $c = \text{confinement factor} = 1.00$ 
 $y1 = 0.00084854$ 
 $sh1 = 0.00271532$ 
 $ft1 = 254.5614$ 
 $fy1 = 212.1345$ 
 $su1 = 0.00271532$ 
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $lo/lou,min = lb/ld = 0.14149197$ 
 $su1 = 0.4*esu1\_nominal ((5.5), TBDY) = 0.032$ 
From table 5A.1, TBDY:  $esu1\_nominal = 0.08$ ,
For calculation of  $esu1\_nominal$  and  $y1, sh1, ft1, fy1$ , it is considered
characteristic value  $fsy1 = fs1/1.2$ , from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25*(lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.
with  $fs1 = fs = 212.1345$ 
with  $Es1 = Es = 200000.00$ 
 $y2 = 0.00084854$ 
 $sh2 = 0.00271532$ 
 $ft2 = 254.5614$ 
 $fy2 = 212.1345$ 
 $su2 = 0.00271532$ 
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $lo/lou,min = lb/lb,min = 0.14149197$ 
 $su2 = 0.4*esu2\_nominal ((5.5), TBDY) = 0.032$ 
From table 5A.1, TBDY:  $esu2\_nominal = 0.08$ ,
For calculation of  $esu2\_nominal$  and  $y2, sh2, ft2, fy2$ , it is considered
characteristic value  $fsy2 = fs2/1.2$ , from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25*(lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.
with  $fs2 = fs = 212.1345$ 
with  $Es2 = Es = 200000.00$ 
 $yv = 0.00084854$ 
 $shv = 0.00271532$ 
 $ftv = 254.5614$ 
 $fyv = 212.1345$ 
 $suv = 0.00271532$ 
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $lo/lou,min = lb/ld = 0.14149197$ 
 $suv = 0.4*esuv\_nominal ((5.5), TBDY) = 0.032$ 
From table 5A.1, TBDY:  $esuv\_nominal = 0.08$ ,
considering characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY
For calculation of  $esuv\_nominal$  and  $yv, shv, ftv, fyv$ , it is considered
characteristic value  $fsyv = fsv/1.2$ , from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$ , are also multiplied by  $\text{Min}(1, 1.25*(lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.
with  $fsv = fs = 212.1345$ 
with  $Esv = Es = 200000.00$ 
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.04110878$ 
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.04110878$ 
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00$ 
and confined core properties:
 $b = 190.00$ 
 $d = 2927.00$ 
 $d' = 13.00$ 
 $fcc (5A.2, TBDY) = 20.00$ 
 $cc (5A.5, TBDY) = 0.002$ 
 $c = \text{confinement factor} = 1.00$ 
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.0546449$ 
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.0546449$ 
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00$ 
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->

```

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

---->

$$su(4.9) = 0.21179234$$

$$Mu = MRc(4.14) = 1.7546E+009$$

$$u = su(4.1) = 1.1650088E-006$$

Calculation of ratio l_b/l_d

$$\text{Lap Length: } l_b/l_d = 0.14149197$$

$$l_b = 300.00$$

$$l_d = 2120.262$$

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

l_d ,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 16.85714$$

$$\text{Mean strength value of all re-bars: } f_y = 625.00$$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of Mu_1 -

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

$$u = 1.1680845E-006$$

$$Mu = 1.8535E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00186094$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

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

The Shear_factor is considered equal to 1 (pure moment strength)

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

$$we(5.4c) = 0.00$$

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

$$ase1 = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$ase2 = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

$$psh_{min} = \text{Min}(psh_x, psh_y) = 0.00069813$$

$$psh_x = ps1_x + ps2_x + ps3_x = 0.00356047$$

$$ps1_x(\text{column 1}) = (As1 * h1 / s_1) / A_c = 0.00083776$$

$$h1 = 600.00$$

$$As1 = Astir1 * ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2_x(\text{column 2}) = (As2 * h2 / s_2) / A_c = 0.00083776$$

$$h2 = 600.00$$

$As2 = Astir2 * ns2 = 157.0796$
 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, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y \text{ (column 1)} = (As1 * h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 * ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,y \text{ (column 2)} = (As2 * h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 * ns2 = 157.0796$
 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, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 625.00$
 $fce = 20.00$
 From ((5.A.5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y1 = 0.00084854$
 $sh1 = 0.00271532$
 $ft1 = 254.5614$
 $fy1 = 212.1345$
 $su1 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/l_d = 0.14149197$
 $su1 = 0.4 * esu1_nominal \text{ ((5.5), TBDY)} = 0.032$
 From table 5A.1, TBDY: $esu1_nominal = 0.08$,
 For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1 / 1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = fs = 212.1345$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00084854$
 $sh2 = 0.00271532$
 $ft2 = 254.5614$
 $fy2 = 212.1345$
 $su2 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/l_b,min = 0.14149197$
 $su2 = 0.4 * esu2_nominal \text{ ((5.5), TBDY)} = 0.032$
 From table 5A.1, TBDY: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2 / 1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = fs = 212.1345$
 with $Es2 = Es = 200000.00$
 $yv = 0.00084854$
 $shv = 0.00271532$
 $ftv = 254.5614$
 $fyv = 212.1345$
 $suv = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.14149197$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esuv_nominal = 0.08$,
considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fsv = fs = 212.1345$
with $Esv = Es = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.04110878$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.04110878$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00883478$
and confined core properties:
 $b = 190.00$
 $d = 2927.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 20.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.0546449$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.0546449$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.01174386$
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied
--->
 $su (4.9) = 0.21386777$
 $Mu = MRc (4.14) = 1.8535E+009$
 $u = su (4.1) = 1.1680845E-006$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$
 $l_b = 300.00$
 $l_d = 2120.262$
Calculation of l_b,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 16.85714$
Mean strength value of all re-bars: $fy = 625.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.24399$
 $n = 28.00$

Calculation of $Mu2+$

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.1650088E-006$
 $Mu = 1.7546E+009$

with full section properties:
 $b = 250.00$
 $d = 2957.00$
 $d' = 43.00$
 $v = 0.00186094$
 $N = 27514.027$

$f_c = 20.00$
 $c_o (5A.5, TBDY) = 0.002$
 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)
 From (5.4b), TBDY: $c_u = 0.0035$
 $w_e (5.4c) = 0.00$
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$
 $a_{se1} = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $a_{se2} = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $a_{se3} = 0$ (grid does not provide confinement)
 $p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$
 $p_{s1,x} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$
 $h_1 = 600.00$
 $A_{s1} = A_{stir1} * n_{s1} = 157.0796$
 No stirups, $n_{s1} = 2.00$
 $p_{s2,x} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$
 $h_2 = 600.00$
 $A_{s2} = A_{stir2} * n_{s2} = 157.0796$
 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, $n_{s3} = 2.00$

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$
 $p_{s1,y} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$
 $h_1 = 250.00$
 $A_{s1} = A_{stir1} * n_{s1} = 157.0796$
 No stirups, $n_{s1} = 2.00$
 $p_{s2,y} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$
 $h_2 = 250.00$
 $A_{s2} = A_{stir2} * n_{s2} = 157.0796$
 No stirups, $n_{s2} = 2.00$
 $p_{s3,y} (\text{web}) = (A_{s3} * h_3 / s_3) / A_c = 0.00$
 $h_3 = 250.00$
 $A_{s3} = A_{stir3} * n_{s3} = 157.0796$
 No stirups, $n_{s3} = 0.00$

$A_{sec} = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $f_{ywe} = 625.00$
 $f_{ce} = 20.00$

From ((5.A5), TBDY), TBDY: $c_c = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y_1 = 0.00084854$
 $sh_1 = 0.00271532$
 $ft_1 = 254.5614$
 $fy_1 = 212.1345$
 $su_1 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = l_b / l_d = 0.14149197$
 $su_1 = 0.4 * esu_1_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_1_{nominal} = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = fs = 212.1345$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00084854$
 $sh2 = 0.00271532$
 $ft2 = 254.5614$
 $fy2 = 212.1345$
 $su2 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou, min = lb/lb, min = 0.14149197$
 $su2 = 0.4 \cdot esu2_nominal \cdot ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = fs = 212.1345$
 with $Es2 = Es = 200000.00$
 $yv = 0.00084854$
 $shv = 0.00271532$
 $ftv = 254.5614$
 $fyv = 212.1345$
 $suv = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou, min = lb/ld = 0.14149197$
 $suv = 0.4 \cdot esuv_nominal \cdot ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 212.1345$
 with $Esv = Es = 200000.00$
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.04110878$
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.04110878$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00$

and confined core properties:

$b = 190.00$
 $d = 2927.00$
 $d' = 13.00$
 $fcc \text{ (5A.2, TBDY)} = 20.00$
 $cc \text{ (5A.5, TBDY)} = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.0546449$
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.0546449$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00$

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

--->
 $v < vs, y2$ - LHS eq.(4.5) is satisfied
 --->
 $su \text{ (4.9)} = 0.21179234$
 $Mu = MRc \text{ (4.14)} = 1.7546E+009$
 $u = su \text{ (4.1)} = 1.1650088E-006$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.14149197$
 $lb = 300.00$
 $ld = 2120.262$
 Calculation of lb, min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

Id,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$db = 16.85714$$

Mean strength value of all re-bars: $f_y = 625.00$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of μ_2 -

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

$$u = 1.1680845E-006$$

$$\mu = 1.8535E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00186094$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

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

The Shear_factor is considered equal to 1 (pure moment strength)

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

$$w_e(5.4c) = 0.00$$

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

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$$

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$$

$$p_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

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

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

$$p_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

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

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

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

$$h_3 = 1800.00$$

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

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

$$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$$

$$p_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

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

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

$$p_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$$

$h2 = 250.00$
 $As2 = Astir2 * ns2 = 157.0796$
 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, $ns3 = 0.00$

 $Asec = 750000.00$

$s_1 = 150.00$

$s_2 = 150.00$

$s_3 = 200.00$

$fywe = 625.00$

$fce = 20.00$

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

$c =$ confinement factor $= 1.00$

$y1 = 0.00084854$

$sh1 = 0.00271532$

$ft1 = 254.5614$

$fy1 = 212.1345$

$su1 = 0.00271532$

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

$lo/lou,min = lb/d = 0.14149197$

$su1 = 0.4 * esu1_nominal ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1$, $sh1$, $ft1$, $fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

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

with $fs1 = fs = 212.1345$

with $Es1 = Es = 200000.00$

$y2 = 0.00084854$

$sh2 = 0.00271532$

$ft2 = 254.5614$

$fy2 = 212.1345$

$su2 = 0.00271532$

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

$lo/lou,min = lb/lb,min = 0.14149197$

$su2 = 0.4 * esu2_nominal ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2$, $sh2$, $ft2$, $fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

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

with $fs2 = fs = 212.1345$

with $Es2 = Es = 200000.00$

$yv = 0.00084854$

$shv = 0.00271532$

$ftv = 254.5614$

$fyv = 212.1345$

$suv = 0.00271532$

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

$lo/lou,min = lb/d = 0.14149197$

$suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esuv_nominal = 0.08$,

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

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

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

with $fsv = fs = 212.1345$

with $Esv = Es = 200000.00$

$1 = Asl,ten / (b * d) * (fs1 / fc) = 0.04110878$

$2 = Asl,com / (b * d) * (fs2 / fc) = 0.04110878$

$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.00883478$
 and confined core properties:
 $b = 190.00$
 $d = 2927.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 20.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.0546449$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.0546449$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.01174386$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.21386777$
 $Mu = MRc (4.14) = 1.8535E+009$
 $u = su (4.1) = 1.1680845E-006$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$
 $l_b = 300.00$
 $l_d = 2120.262$
 Calculation of l_b,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $f_y = 625.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 1.7981E+006$

Calculation of Shear Strength at edge 1, $V_{r1} = 1.7981E+006$
 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: $V_c = 729988.83$
 $Mu/V_u - l_w/2 = 0.00 \leq 0$
 $= 1$ (normal-weight concrete)
 $f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 250.00$
 $d = 2400.00$
 $l_w = 3000.00$
 $Mu = 1.6689249E-009$
 $V_u = 2.0194839E-028$
 $Nu = 27514.027$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0681E+006$
 $V_{s1} = 251327.412$ is calculated for pseudo-Column 1, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 500.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)
 $V_{s2} = 251327.412$ is calculated for pseudo-Column 2, with:

d = 480.00

Av = 157079.633

s = 150.00

fy = 500.00

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

Vs3 = 565486.678 is calculated for web, with:

d = 1440.00

Av = 157079.633

s = 200.00

fy = 500.00

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 <= 1.7825E+006

bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 1.7981E+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 = 729988.83

Mu/Vu-lw/2 = 0.00 <= 0

= 1 (normal-weight concrete)

fc' = 20.00, but $fc' \cdot 0.5 \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

h = 250.00

d = 2400.00

lw = 3000.00

Mu = 1.6689249E-009

Vu = 2.0194839E-028

Nu = 27514.027

From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 + Vs3 = 1.0681E+006

Vs1 = 251327.412 is calculated for pseudo-Column 1, with:

d = 480.00

Av = 157079.633

s = 150.00

fy = 500.00

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

Vs2 = 251327.412 is calculated for pseudo-Column 2, with:

d = 480.00

Av = 157079.633

s = 150.00

fy = 500.00

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

Vs3 = 565486.678 is calculated for web, with:

d = 1440.00

Av = 157079.633

s = 200.00

fy = 500.00

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 <= 1.7825E+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:
New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 20.00$ 
New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 500.00$ 
Concrete Elasticity,  $E_c = 25742.96$ 
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
New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 625.00$ 
#####
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
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length  $l_o = 300.00$ 
No FRP Wrapping
-----

Stepwise Properties
-----
At local axis: 2
EDGE -A-
Shear Force,  $V_a = -4.7331654E-030$ 
EDGE -B-
Shear Force,  $V_b = 4.7331654E-030$ 
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:  $As_{t,ten} = 2368.761$ 
-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 ,  $V_e/V_r = 0.08592175$ 
Member Controlled by Flexure ( $V_e/V_r < 1$ )
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n = 71719.625$ 
with
 $M_{pr1} = \text{Max}(Mu_{1+} , Mu_{1-}) = 1.0758E+008$ 
 $Mu_{1+} = 8.8591E+007$ , is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
 $Mu_{1-} = 1.0758E+008$ , is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(Mu_{2+} , Mu_{2-}) = 1.0758E+008$ 
 $Mu_{2+} = 8.8591E+007$ , is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
 $Mu_{2-} = 1.0758E+008$ , 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  $Mu_{1+}$ 
-----

```

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

$$\phi_u = 1.7029732E-005$$

$$M_u = 8.8591E+007$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$\nu = 0.00220465$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

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

The Shear_factor is considered equal to 1 (pure moment strength)

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

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

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

$$\phi_{ase1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$\phi_{ase2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

$$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.00069813$$

$$\phi_{psh,x} = \phi_{ps1,x} + \phi_{ps2,x} + \phi_{ps3,x} = 0.00356047$$

$$\phi_{ps1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

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

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

$$\phi_{ps2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

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

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

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

$$h_3 = 1800.00$$

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

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

$$\phi_{psh,y} = \phi_{ps1,y} + \phi_{ps2,y} + \phi_{ps3,y} = 0.00069813$$

$$\phi_{ps1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

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

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

$$\phi_{ps2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

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

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

$$\phi_{ps3,y} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

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

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

$$A_{sec} = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 625.00$$

$$f_{ce} = 20.00$$

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

```

c = confinement factor = 1.00
y1 = 0.00084854
sh1 = 0.00271532
ft1 = 254.5614
fy1 = 212.1345
su1 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 212.1345
with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04026409
2 = Asl,com/(b*d)*(fs2/fc) = 0.04026409
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) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04801038
2 = Asl,com/(b*d)*(fs2/fc) = 0.04801038
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

```

--->

$$su(4.9) = 0.23343312$$

$$Mu = MRc(4.14) = 8.8591E+007$$

$$u = su(4.1) = 1.7029732E-005$$

Calculation of ratio lb/ld

$$\text{Lap Length: } lb/ld = 0.14149197$$

$$lb = 300.00$$

$$ld = 2120.262$$

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

ld_{min} from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$db = 16.85714$$

Mean strength value of all re-bars: $f_y = 625.00$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of Mu_1 -

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

$$u = 1.7245646E-005$$

$$Mu = 1.0758E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00220465$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

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

The Shear_factor is considered equal to 1 (pure moment strength)

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

$$we(5.4c) = 0.00$$

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

$$ase1 = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$ase2 = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

$$psh_{min} = \text{Min}(psh_x, psh_y) = 0.00069813$$

$$psh_x = ps1_x + ps2_x + ps3_x = 0.00356047$$

$$ps1_x(\text{column 1}) = (As1 * h1 / s_1) / A_c = 0.00083776$$

$$h1 = 600.00$$

$$As1 = Astir1 * ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2_x(\text{column 2}) = (As2 * h2 / s_2) / A_c = 0.00083776$$

$$h2 = 600.00$$

$$As2 = Astir2 * ns2 = 157.0796$$

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

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirups, ns1 = 2.00
 $ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 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

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 625.00$
 $fce = 20.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y1 = 0.00084854$
 $sh1 = 0.00271532$
 $ft1 = 254.5614$
 $fy1 = 212.1345$
 $su1 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/ld = 0.14149197$
 $su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.032$
 From table 5A.1, TBDY: $esu1_nominal = 0.08$,
 For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1 / 1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = fs = 212.1345$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00084854$
 $sh2 = 0.00271532$
 $ft2 = 254.5614$
 $fy2 = 212.1345$
 $su2 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/lb,min = 0.14149197$
 $su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.032$
 From table 5A.1, TBDY: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2 / 1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = fs = 212.1345$
 with $Es2 = Es = 200000.00$
 $yv = 0.00084854$
 $shv = 0.00271532$
 $ftv = 254.5614$
 $fyv = 212.1345$
 $suv = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 0.14149197$
 $s_u = 0.4 * e_{suv_nominal}((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $e_{suv_nominal} = 0.08$,
 considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $e_{suv_nominal}$ and y_v , sh_v, ft_v, fy_v , it is considered
 characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = f_s = 212.1345$
 with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b*d) * (f_{s1}/f_c) = 0.04026409$
 $2 = A_{sl,com}/(b*d) * (f_{s2}/f_c) = 0.04026409$
 $v = A_{sl,mid}/(b*d) * (f_{sv}/f_c) = 0.02734113$

and confined core properties:

$b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 20.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d) * (f_{s1}/f_c) = 0.04801038$
 $2 = A_{sl,com}/(b*d) * (f_{s2}/f_c) = 0.04801038$
 $v = A_{sl,mid}/(b*d) * (f_{sv}/f_c) = 0.03260121$

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

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $s_u (4.9) = 0.24303049$
 $\mu_u = M_{Rc} (4.14) = 1.0758E+008$
 $u = s_u (4.1) = 1.7245646E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$
 $l_b = 300.00$
 $l_d = 2120.262$
 Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $f_y = 625.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

Calculation of μ_{u2+}

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.7029732E-005$
 $\mu_u = 8.8591E+007$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00220465$
 $N = 27514.027$
 $f_c = 20.00$

$co (5A.5, TBDY) = 0.002$
 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: $cu = 0.0035$
 $we (5.4c) = 0.00$
 $ase ((5.4d), TBDY) = (ase1*Acol1+ase2*Acol2+ase3*Aweb)/Asec = 0.00$
 $ase1 = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $ase2 = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $ase3 = 0$ (grid does not provide confinement)
 $psh,min = Min(psh,x , psh,y) = 0.00069813$

$psh,x = ps1,x+ps2,x+ps3,x = 0.00356047$
 $ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1*ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2*ns2 = 157.0796$
 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, $ns3 = 2.00$

$psh,y = ps1,y+ps2,y+ps3,y = 0.00069813$
 $ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1*ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2*ns2 = 157.0796$
 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, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 625.00$
 $fce = 20.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c =$ confinement factor = 1.00
 $y1 = 0.00084854$
 $sh1 = 0.00271532$
 $ft1 = 254.5614$
 $fy1 = 212.1345$
 $su1 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/d = 0.14149197$
 $su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu1_nominal = 0.08$,
 For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered

characteristic value $f_{sy1} = f_{s1}/1.2$, 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, ASCE 41-17.
 with $f_{s1} = f_s = 212.1345$
 with $E_{s1} = E_s = 200000.00$
 $y2 = 0.00084854$
 $sh2 = 0.00271532$
 $ft2 = 254.5614$
 $fy2 = 212.1345$
 $su2 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_{b,min} = 0.14149197$
 $su2 = 0.4 \cdot esu2_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu2_{nominal} = 0.08$,
 For calculation of $esu2_{nominal}$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $f_{sy2} = f_{s2}/1.2$, 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, ASCE 41-17.
 with $f_{s2} = f_s = 212.1345$
 with $E_{s2} = E_s = 200000.00$
 $yv = 0.00084854$
 $shv = 0.00271532$
 $ftv = 254.5614$
 $fyv = 212.1345$
 $suv = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 0.14149197$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and 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, ASCE 41-17.
 with $f_{sv} = f_s = 212.1345$
 with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.04026409$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.04026409$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$

and confined core properties:

$b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 20.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.04801038$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.04801038$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$

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

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

--->
 $su (4.9) = 0.23343312$
 $Mu = MR_c (4.14) = 8.8591E+007$
 $u = su (4.1) = 1.7029732E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$
 $l_b = 300.00$
 $l_d = 2120.262$
 Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

```

= 1
db = 16.85714
Mean strength value of all re-bars: fy = 625.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

```

Calculation of Mu2-

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

```

u = 1.7245646E-005
Mu = 1.0758E+008

```

with full section properties:

```

b = 3000.00
d = 208.00
d' = 42.00
v = 0.00220465
N = 27514.027
fc = 20.00
co (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:  $\phi_u = 0.0035$ 
we (5.4c) = 0.00
ase ((5.4d), TBDY) = (ase1*Acol1+ase2*Acol2+ase3*Aweb)/Asec = 0.00
ase1 = 0.00
sh_1 = 150.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 150.00
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) = 0.00069813

```

```

psh,x = ps1,x+ps2,x+ps3,x = 0.00356047
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00083776
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776
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 = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
h2 = 250.00

```

$As_2 = Astir_2 * ns_2 = 157.0796$
 No stirups, $ns_2 = 2.00$
 $ps_3, y_{(web)} = (As_3 * h_3 / s_3) / A_c = 0.00$
 $h_3 = 250.00$
 $As_3 = Astir_3 * ns_3 = 157.0796$
 No stirups, $ns_3 = 0.00$

$A_{sec} = 750000.00$

$s_1 = 150.00$

$s_2 = 150.00$

$s_3 = 200.00$

$fy_{we} = 625.00$

$f_{ce} = 20.00$

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

$c =$ confinement factor $= 1.00$

$y_1 = 0.00084854$

$sh_1 = 0.00271532$

$ft_1 = 254.5614$

$fy_1 = 212.1345$

$su_1 = 0.00271532$

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

$lo/lou, min = lb/ld = 0.14149197$

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

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

For calculation of $esu_1_{nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.

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

with $fs_1 = fs = 212.1345$

with $Es_1 = Es = 200000.00$

$y_2 = 0.00084854$

$sh_2 = 0.00271532$

$ft_2 = 254.5614$

$fy_2 = 212.1345$

$su_2 = 0.00271532$

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

$lo/lou, min = lb/lb, min = 0.14149197$

$su_2 = 0.4 * esu_2_{nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu_2_{nominal} = 0.08$,

For calculation of $esu_2_{nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.

y_2, sh_2, ft_2, fy_2 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_2 = fs = 212.1345$

with $Es_2 = Es = 200000.00$

$y_v = 0.00084854$

$sh_v = 0.00271532$

$ft_v = 254.5614$

$fy_v = 212.1345$

$suv = 0.00271532$

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

$lo/lou, min = lb/ld = 0.14149197$

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

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

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

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

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

with $fsv = fs = 212.1345$

with $Esv = Es = 200000.00$

$1 = Asl, ten / (b * d) * (fs_1 / f_c) = 0.04026409$

$2 = Asl, com / (b * d) * (fs_2 / f_c) = 0.04026409$

$v = Asl, mid / (b * d) * (fsv / f_c) = 0.02734113$

and confined core properties:

$$b = 2940.00$$

$$d = 178.00$$

$$d' = 12.00$$

$$f_{cc} (5A.2, TBDY) = 20.00$$

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

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

$$1 = A_{s1,ten}/(b*d)*(f_{s1}/f_c) = 0.04801038$$

$$2 = A_{s2,com}/(b*d)*(f_{s2}/f_c) = 0.04801038$$

$$v = A_{s,mid}/(b*d)*(f_{sv}/f_c) = 0.03260121$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$s_u (4.9) = 0.24303049$$

$$\mu_u = M_{Rc} (4.14) = 1.0758E+008$$

$$u = s_u (4.1) = 1.7245646E-005$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$

$$l_b = 300.00$$

$$l_d = 2120.262$$

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

l_d, \min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 16.85714$$

Mean strength value of all re-bars: $f_y = 625.00$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 834708.585$

Calculation of Shear Strength at edge 1, $V_{r1} = 834708.585$

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: $V_c = 729988.83$

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

$$= 1 \text{ (normal-weight concrete)}$$

$$f'_c = 20.00, \text{ but } f'_c^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$h = 3000.00$$

$$d = 200.00$$

$$l_w = 250.00$$

$$\mu_u = 3.9108324E-011$$

$$V_u = 4.7331654E-030$$

$$N_u = 27514.027$$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 104719.755$

$V_{s1} = 52359.878$ is calculated for pseudo-Column 1, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 500.00$$

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

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

$V_{s2} = 52359.878$ is calculated for pseudo-Column 2, with:

d = 200.00

Av = 157079.633

s = 150.00

fy = 500.00

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

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

Vs3 = 0.00 is calculated for web, with:

d = 200.00

Av = 0.00

s = 200.00

fy = 500.00

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: $V_s + V_f \leq 1.7825E+006$

bw = 3000.00

Calculation of Shear Strength at edge 2, Vr2 = 834708.585

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) '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 = 729988.83

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

= 1 (normal-weight concrete)

$f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

h = 3000.00

d = 200.00

lw = 250.00

$\mu_u = 3.9108324E-011$

$\mu_l = 4.7331654E-030$

$\mu_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 104719.755$

Vs1 = 52359.878 is calculated for pseudo-Column 1, with:

d = 200.00

Av = 157079.633

s = 150.00

fy = 500.00

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

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

Vs2 = 52359.878 is calculated for pseudo-Column 2, with:

d = 200.00

Av = 157079.633

s = 150.00

fy = 500.00

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

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

Vs3 = 0.00 is calculated for web, with:

d = 200.00

Av = 0.00

s = 200.00

fy = 500.00

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: $V_s + V_f \leq 1.7825E+006$

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: 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
 $\rho_n = 0.00069813$

with $\rho_n = \rho_{n1} + \rho_{n2} + \rho_{n3}$, being the shear reinf. ratio in a plane perpendicular to the shear axis 2
(pseudo-col.1 $\rho_{n1} = A_{s1} \cdot b_1 / s_1 = (A_{s1} \cdot h_1 / s_1) / A_c = 0.00034907$

$h_1 = 250.00$

$s_1 = 150.00$

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

(pseudo-col.2 $\rho_{n2} = A_{s2} \cdot b_2 / s_2 = (A_{s2} \cdot h_2 / s_2) / A_c = 0.00034907$

$h_2 = 250.00$

$s_2 = 150.00$

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:

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

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

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_b = 300.00$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 4.0958227E-010$

Shear Force, $V_2 = 1.8122959E-014$

Shear Force, $V_3 = -19169.48$

Axial Force, $F = -29697.588$

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, $D_bL = 17.20$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.00276728$

$u = y + p = 0.00276728$

- Calculation of y -

$$y = (M_y \cdot I_p) / (E I)_{\text{Eff}} = 0.00076728 \text{ ((10-5), ASCE 41-17)}$$
$$M_y = 1.1252 \text{E+008}$$
$$(E I)_{\text{Eff}} = 0.35 \cdot E_c \cdot I \text{ (table 10-5)}$$
$$E_c \cdot I = 1.0056 \text{E+014}$$
$$I_p = 0.5 \cdot d = 0.5 \cdot (0.8 \cdot h) = 240.00$$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$$y = \text{Min}(y_{\text{ten}}, y_{\text{com}})$$
$$y_{\text{ten}} = 6.2580201 \text{E-006}$$
$$\text{with ((10.1), ASCE 41-17)} \quad f_y = \text{Min}(f_y, 1.25 \cdot f_y \cdot (I_b / I_d)^{2/3}) = 196.9282$$
$$d = 208.00$$
$$y = 0.24355457$$
$$A = 0.01041157$$
$$B = 0.00635339$$
$$\text{with } p_t = 0.00379609$$
$$p_c = 0.00379609$$
$$p_v = 0.00257772$$
$$N = 29697.588$$
$$b = 3000.00$$
$$" = 0.20192308$$
$$y_{\text{comp}} = 2.7999955 \text{E-005}$$
$$\text{with } f_c = 20.00$$
$$E_c = 25742.96$$
$$y = 0.24011724$$
$$A = 0.00999974$$
$$B = 0.00611172$$
$$\text{with } E_s = 200000.00$$

Calculation of ratio I_b / I_d

$$\text{Lap Length: } I_d / I_{d,\text{min}} = 0.17686496$$
$$I_b = 300.00$$
$$I_d = 1696.209$$
$$\text{Calculation of } I \text{ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.}$$
$$I_{d,\text{min}} \text{ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)}$$
$$= 1$$
$$d_b = 16.85714$$
$$\text{Mean strength value of all re-bars: } f_y = 500.00$$
$$t = 1.00$$
$$s = 0.80$$
$$e = 1.00$$
$$c_b = 25.00$$
$$K_{tr} = 2.24399$$
$$n = 28.00$$

- Calculation of p -

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

with:

$$\text{- Condition i (shear wall and wall segments)}$$
$$\text{- } (A_s - A_s') \cdot f_y + P / (t_w \cdot I_w \cdot f_c') = -0.20955407$$
$$A_s = 0.00$$
$$A_s' = 6346.017$$
$$f_y = 500.00$$
$$P = 29697.588$$

$t_w = 3000.00$
 $l_w = 250.00$
 $f_c = 20.00$
 - $V/(t_w \cdot l_w \cdot f_c^{0.5}) = 6.5069293E-020$, NOTE: units in lb & in
 - Confined Boundary: No
 Boundary hoops spacing exceed $8d_b$ ($s_1 > 8 \cdot d_b$ or $s_2 > 8 \cdot d_b$)
 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:
 $V_{w1} = 104719.755$
 $s_1 = 150.00$
 Boundary Element 2:
 $V_{w2} = 104719.755$
 $s_2 = 150.00$
 Grid Shear Force, $V_{w3} = 0.00$
 Concrete Shear Force, $V_c = 137201.648$
 (The variables above have already been given in Shear control ratio calculation)
 Mean diameter of all bars, $d_b = 17.33333$
 Design Shear Force, $V = 1.8122959E-014$

 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 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: (d)
Section Type: rcrcws

Constant Properties

Knowledge Factor, $\gamma = 1.00$
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$
New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$
Concrete Elasticity, $E_c = 25742.96$
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
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_o = l_b = 300.00$
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, $M_a = 4.0958227E-010$
Shear Force, $V_a = 1.8122959E-014$
EDGE -B-
Bending Moment, $M_b = -3.5014360E-010$
Shear Force, $V_b = -1.8122959E-014$
BOTH EDGES
Axial Force, $F = -29697.588$
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, $Db_{L,ten} = 17.20$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 242440.404$
From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c'^{0.5} \cdot h \cdot d = 242440.404$

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).

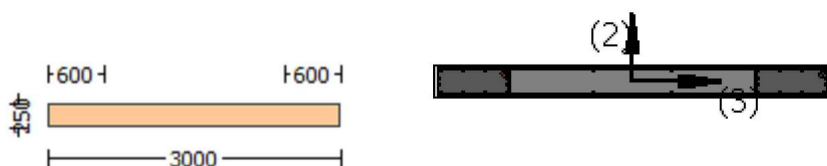
From Table (11.5.4.6(d-e)), ACI 318-14: $V_c = 137720.649$
 $M_u/V_u - l_w/2 = 19195.443 > 0$
 $= 1$ (normal-weight concrete)
 $f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 3000.00$
 $d = 200.00$
 $l_w = 250.00$
 $M_u = 3.5014360E-010$
 $V_u = 1.8122959E-014$
 $N_u = 29697.588$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 104719.755$
 $V_{s1} = 52359.878$ is calculated for pseudo-Column 1, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 500.00$
 V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 $V_{s2} = 52359.878$ is calculated for pseudo-Column 2, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 500.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 $V_{s3} = 0.00$ is calculated for web, with:
 $d = 200.00$
 $A_v = 0.00$
 $s = 200.00$
 $f_y = 500.00$
 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: $V_s + V_f \leq 1.7825E+006$
 $b_w = 3000.00$

End Of Calculation of Shear Capacity for element: wall W1 of floor 1
At local axis: 2
Integration Section: (d)

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 (μ)
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:

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

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

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

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 625.00$

#####

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

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = 300.00$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 2.0194839E-028$

EDGE -B-

Shear Force, $V_b = -2.0194839E-028$

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: $A_{st,ten} = 2865.133$

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

-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, $V_e/V_r = 0.68720049$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 1.2357E+006$
with

$M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 1.8535E+009$

$\mu_{u1+} = 1.7546E+009$, 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

$\mu_{u1-} = 1.8535E+009$, 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

$$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 1.8535\text{E}+009$$

$M_{u2+} = 1.7546\text{E}+009$, 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

$M_{u2-} = 1.8535\text{E}+009$, 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 ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$\phi_u = 1.1650088\text{E}-006$$

$$M_u = 1.7546\text{E}+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00186094$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

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

The Shear_factor is considered equal to 1 (pure moment strength)

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

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

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

$$\phi_{ase1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$\phi_{ase2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

$$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.00069813$$

$$\phi_{psh,x} = \phi_{ps1,x} + \phi_{ps2,x} + \phi_{ps3,x} = 0.00356047$$

$$\phi_{ps1,x} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

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

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

$$\phi_{ps2,x} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

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

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

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

$$h_3 = 1800.00$$

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

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

$$\phi_{psh,y} = \phi_{ps1,y} + \phi_{ps2,y} + \phi_{ps3,y} = 0.00069813$$

$$\phi_{ps1,y} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

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

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

$$\phi_{ps2,y} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

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

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

$$\phi_{ps3,y} (\text{web}) = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

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

No stirrups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 625.00

fce = 20.00

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

c = confinement factor = 1.00

y1 = 0.00084854

sh1 = 0.00271532

ft1 = 254.5614

fy1 = 212.1345

su1 = 0.00271532

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

lo/lou,min = lb/ld = 0.14149197

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

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

with fs1 = fs = 212.1345

with Es1 = Es = 200000.00

y2 = 0.00084854

sh2 = 0.00271532

ft2 = 254.5614

fy2 = 212.1345

su2 = 0.00271532

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

lo/lou,min = lb/lb,min = 0.14149197

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

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

with fs2 = fs = 212.1345

with Es2 = Es = 200000.00

yv = 0.00084854

shv = 0.00271532

ftv = 254.5614

fyv = 212.1345

suv = 0.00271532

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

lo/lou,min = lb/ld = 0.14149197

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

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

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

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

with fsv = fs = 212.1345

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.04110878

2 = Asl,com/(b*d)*(fs2/fc) = 0.04110878

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) = 20.00

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

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

$$1 = Asl_{ten}/(b*d)*(fs1/fc) = 0.0546449$$

$$2 = Asl_{com}/(b*d)*(fs2/fc) = 0.0546449$$

$$v = Asl_{mid}/(b*d)*(fsv/fc) = 0.00$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$su \text{ (4.9)} = 0.21179234$$

$$Mu = MRc \text{ (4.14)} = 1.7546E+009$$

$$u = su \text{ (4.1)} = 1.1650088E-006$$

Calculation of ratio lb/ld

$$\text{Lap Length: } lb/ld = 0.14149197$$

$$lb = 300.00$$

$$ld = 2120.262$$

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

ld_{min} from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$db = 16.85714$$

$$\text{Mean strength value of all re-bars: } fy = 625.00$$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$Ktr = 2.24399$$

$$n = 28.00$$

Calculation of $Mu1$ -

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

$$u = 1.1680845E-006$$

$$Mu = 1.8535E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00186094$$

$$N = 27514.027$$

$$fc = 20.00$$

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

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

The Shear_factor is considered equal to 1 (pure moment strength)

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

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

$$ase \text{ ((5.4d), TBDY)} = (ase1*Acol1 + ase2*Acol2 + ase3*Aweb)/Asec = 0.00$$

$$ase1 = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$ase2 = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

$$psh_{min} = \text{Min}(psh_x, psh_y) = 0.00069813$$

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,x \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 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, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 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, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 625.00$
 $fce = 20.00$

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

$y1 = 0.00084854$
 $sh1 = 0.00271532$
 $ft1 = 254.5614$
 $fy1 = 212.1345$
 $su1 = 0.00271532$

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

$lo/lou,min = lb/ld = 0.14149197$

$su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

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

with $fs1 = fs = 212.1345$

with $Es1 = Es = 200000.00$

$y2 = 0.00084854$
 $sh2 = 0.00271532$
 $ft2 = 254.5614$
 $fy2 = 212.1345$
 $su2 = 0.00271532$

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

$lo/lou,min = lb/lb,min = 0.14149197$

$su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

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

```

with fs2 = fs = 212.1345
with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04110878
2 = Asl,com/(b*d)*(fs2/fc) = 0.04110878
v = Asl,mid/(b*d)*(fsv/fc) = 0.00883478
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0546449
2 = Asl,com/(b*d)*(fs2/fc) = 0.0546449
v = Asl,mid/(b*d)*(fsv/fc) = 0.01174386
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.21386777
Mu = MRc (4.14) = 1.8535E+009
u = su (4.1) = 1.1680845E-006

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.14149197
lb = 300.00
ld = 2120.262
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 625.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

```

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.1650088E-006

$$\mu = 1.7546E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00186094$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

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

The Shear_factor is considered equal to 1 (pure moment strength)

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

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

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

$$\phi_{se1} = 0.00$$

$$s_{h1} = 150.00$$

$$b_{o1} = 190.00$$

$$h_{o1} = 540.00$$

$$b_{i2,1} = 655400.00$$

$$\phi_{se2} = 0.00$$

$$s_{h2} = 150.00$$

$$b_{o2} = 190.00$$

$$h_{o2} = 540.00$$

$$b_{i2,2} = 655400.00$$

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

$$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00069813$$

$$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00356047$$

$$\phi_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

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

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

$$\phi_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

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

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

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

$$h_3 = 1800.00$$

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

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

$$\phi_{sh,y} = \phi_{s1,y} + \phi_{s2,y} + \phi_{s3,y} = 0.00069813$$

$$\phi_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

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

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

$$\phi_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

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

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

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

$$h_3 = 250.00$$

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

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

$$A_{sec} = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 625.00$$

$$f_{ce} = 20.00$$

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

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

$$y_1 = 0.00084854$$

$$s_{h1} = 0.00271532$$

$$f_{t1} = 254.5614$$

```

fy1 = 212.1345
su1 = 0.00271532
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.14149197
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs1 = fs = 212.1345
    with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.14149197
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = fs = 212.1345
    with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.14149197
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = fs = 212.1345
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04110878
2 = Asl,com/(b*d)*(fs2/fc) = 0.04110878
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) = 20.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.0546449
    2 = Asl,com/(b*d)*(fs2/fc) = 0.0546449
    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) = 0.21179234
Mu = MRc (4.14) = 1.7546E+009
u = su (4.1) = 1.1650088E-006

```

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$

$l_b = 300.00$

$l_d = 2120.262$

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

l_d ,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$= 1$

$db = 16.85714$

Mean strength value of all re-bars: $f_y = 625.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of μ_2 -

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

$\mu = 1.1680845E-006$

$\mu_u = 1.8535E+009$

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$

$v = 0.00186094$

$N = 27514.027$

$f_c = 20.00$

ϕ_c (5A.5, TBDY) = 0.002

Final value of ϕ_{cu} : $\phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_c) = 0.0035$

The Shear_factor is considered equal to 1 (pure moment strength)

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

ϕ_{we} (5.4c) = 0.00

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

$\phi_{ase1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$\phi_{ase2} = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

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

$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.00069813$

$\phi_{psh,x} = \phi_{ps1,x} + \phi_{ps2,x} + \phi_{ps3,x} = 0.00356047$

$\phi_{ps1,x}$ (column 1) = $(A_{s1} * h_1 / s_1) / A_c = 0.00083776$

$h_1 = 600.00$

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

No stirups, $n_{s1} = 2.00$

$\phi_{ps2,x}$ (column 2) = $(A_{s2} * h_2 / s_2) / A_c = 0.00083776$

$h_2 = 600.00$

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

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, ns3 = 2.00

psh,y = ps1,y+ps2,y+ps3,y = 0.00069813

ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907

h1 = 250.00

As1 = Astir1*ns1 = 157.0796

No stirups, ns1 = 2.00

ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907

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 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 625.00

fce = 20.00

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

c = confinement factor = 1.00

y1 = 0.00084854

sh1 = 0.00271532

ft1 = 254.5614

fy1 = 212.1345

su1 = 0.00271532

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

lo/lou,min = lb/lb = 0.14149197

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

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

with fs1 = fs = 212.1345

with Es1 = Es = 200000.00

y2 = 0.00084854

sh2 = 0.00271532

ft2 = 254.5614

fy2 = 212.1345

su2 = 0.00271532

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

lo/lou,min = lb/lb,min = 0.14149197

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

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

with fs2 = fs = 212.1345

with Es2 = Es = 200000.00

yv = 0.00084854

shv = 0.00271532

ftv = 254.5614

fyv = 212.1345

suv = 0.00271532

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

lo/lou,min = lb/lb = 0.14149197

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
For calculation of $e_{suv_nominal}$ and y_v , sh_v , ft_v , f_{yv} , it is considered
characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.

y_1 , sh_1 , ft_1 , f_{y1} , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $f_{sv} = f_s = 212.1345$

with $E_{sv} = E_s = 200000.00$

$1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.04110878$

$2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.04110878$

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00883478$

and confined core properties:

$b = 190.00$

$d = 2927.00$

$d' = 13.00$

f_{cc} (5A.2, TBDY) = 20.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

$1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.0546449$

$2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.0546449$

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.01174386$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.21386777

$Mu = MR_c$ (4.14) = 1.8535E+009

$u = su$ (4.1) = 1.1680845E-006

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$

$l_b = 300.00$

$l_d = 2120.262$

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

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$db = 16.85714$

Mean strength value of all re-bars: $f_y = 625.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 1.7981E+006$

Calculation of Shear Strength at edge 1, $V_{r1} = 1.7981E+006$

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: $V_c = 729988.83$

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

= 1 (normal-weight concrete)

$f'_c = 20.00$, but $f'_c \cdot 0.5 \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$Mu = 1.6689249E-009$

$V_u = 2.0194839E-028$

$Nu = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0681\text{E}+006$

$V_{s1} = 251327.412$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

$V_{s2} = 251327.412$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

$V_{s3} = 565486.678$ is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 500.00$

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: $V_s + V_f \leq 1.7825\text{E}+006$

$b_w = 250.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 1.7981\text{E}+006$

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: $V_c = 729988.83$

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

$= 1$ (normal-weight concrete)

$f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3 \text{ MPa}$ (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 1.6689249\text{E}-009$

$V_u = 2.0194839\text{E}-028$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0681\text{E}+006$

$V_{s1} = 251327.412$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

$V_{s2} = 251327.412$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

$V_{s3} = 565486.678$ is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 500.00$

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: $V_s + V_f \leq 1.7825\text{E}+006$

$b_w = 250.00$

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:

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

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

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

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 625.00$

#####

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

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = 300.00$

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = -4.7331654E-030$

EDGE -B-

Shear Force, $V_b = 4.7331654E-030$

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: $A_{sl,ten} = 2368.761$

-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, $V_e/V_r = 0.08592175$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 71719.625$

with

$M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 1.0758E+008$

$\mu_{u1+} = 8.8591E+007$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$\mu_{u1-} = 1.0758E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

$M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 1.0758E+008$

Mu2+ = 8.8591E+007, 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- = 1.0758E+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 ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$\phi_u = 1.7029732E-005$$

$$M_u = 8.8591E+007$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00220465$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, c_o) = 0.0035$$

The Shear_factor is considered equal to 1 (pure moment strength)

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

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

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

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

$$psh_{min} = \text{Min}(psh_x, psh_y) = 0.00069813$$

$$psh_x = ps1_x + ps2_x + ps3_x = 0.00356047$$

$$ps1_x(\text{column 1}) = (As1 * h1 / s_1) / A_c = 0.00083776$$

$$h1 = 600.00$$

$$As1 = Astir1 * ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2_x(\text{column 2}) = (As2 * h2 / s_2) / A_c = 0.00083776$$

$$h2 = 600.00$$

$$As2 = Astir2 * ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3_x(\text{web}) = (As3 * h3 / s_3) / A_c = 0.00188496$$

$$h3 = 1800.00$$

$$As3 = Astir3 * ns3 = 0.00$$

$$\text{No stirups, } ns3 = 2.00$$

$$psh_y = ps1_y + ps2_y + ps3_y = 0.00069813$$

$$ps1_y(\text{column 1}) = (As1 * h1 / s_1) / A_c = 0.00034907$$

$$h1 = 250.00$$

$$As1 = Astir1 * ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2_y(\text{column 2}) = (As2 * h2 / s_2) / A_c = 0.00034907$$

$$h2 = 250.00$$

$$As2 = Astir2 * ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3_y(\text{web}) = (As3 * h3 / s_3) / A_c = 0.00$$

$$h3 = 250.00$$

$$As3 = Astir3 * ns3 = 157.0796$$

$$\text{No stirups, } ns3 = 0.00$$

```

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 625.00
fce = 20.00
From ((5.A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00084854
sh1 = 0.00271532
ft1 = 254.5614
fy1 = 212.1345
su1 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 212.1345
with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04026409
2 = Asl,com/(b*d)*(fs2/fc) = 0.04026409
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) = 20.00
cc (5A.5, TBDY) = 0.002

```

```

c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04801038
2 = Asl,com/(b*d)*(fs2/fc) = 0.04801038
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) = 0.23343312
Mu = MRc (4.14) = 8.8591E+007
u = su (4.1) = 1.7029732E-005

```

Calculation of ratio lb/d

```

Lap Length: lb/d = 0.14149197
lb = 300.00
ld = 2120.262
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 625.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

```

Calculation of Mu1-

```

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.7245646E-005
Mu = 1.0758E+008

```

with full section properties:

```

b = 3000.00
d = 208.00
d' = 42.00
v = 0.00220465
N = 27514.027
fc = 20.00
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 = 150.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 150.00
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) = 0.00069813

```

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,x \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 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, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 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, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 625.00$
 $fce = 20.00$

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

$y1 = 0.00084854$
 $sh1 = 0.00271532$
 $ft1 = 254.5614$
 $fy1 = 212.1345$
 $su1 = 0.00271532$

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

$lo/lou,min = lb/ld = 0.14149197$
 $su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

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

with $fs1 = fs = 212.1345$
 with $Es1 = Es = 200000.00$

$y2 = 0.00084854$
 $sh2 = 0.00271532$
 $ft2 = 254.5614$
 $fy2 = 212.1345$
 $su2 = 0.00271532$

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

$lo/lou,min = lb/lb,min = 0.14149197$
 $su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

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

with $fs2 = fs = 212.1345$

```

with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04026409
2 = Asl,com/(b*d)*(fs2/fc) = 0.04026409
v = Asl,mid/(b*d)*(fsv/fc) = 0.02734113
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04801038
2 = Asl,com/(b*d)*(fs2/fc) = 0.04801038
v = Asl,mid/(b*d)*(fsv/fc) = 0.03260121
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.24303049
Mu = MRc (4.14) = 1.0758E+008
u = su (4.1) = 1.7245646E-005
-----

Calculation of ratio lb/ld
-----
Lap Length: lb/ld = 0.14149197
lb = 300.00
ld = 2120.262
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 625.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00
-----

Calculation of Mu2+
-----

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.7029732E-005
Mu = 8.8591E+007

```

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00220465$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

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

The Shear_factor is considered equal to 1 (pure moment strength)

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

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

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

$$\phi_{se1} = 0.00$$

$$s_{h1} = 150.00$$

$$b_{o1} = 190.00$$

$$h_{o1} = 540.00$$

$$b_{i2,1} = 655400.00$$

$$\phi_{se2} = 0.00$$

$$s_{h2} = 150.00$$

$$b_{o2} = 190.00$$

$$h_{o2} = 540.00$$

$$b_{i2,2} = 655400.00$$

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

$$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00069813$$

$$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00356047$$

$$\phi_{s1,x} (\text{column 1}) = (A_{s1} * h_1 / s_{h1}) / A_c = 0.00083776$$

$$h_1 = 600.00$$

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

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

$$\phi_{s2,x} (\text{column 2}) = (A_{s2} * h_2 / s_{h2}) / A_c = 0.00083776$$

$$h_2 = 600.00$$

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

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

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

$$h_3 = 1800.00$$

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

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

$$\phi_{sh,y} = \phi_{s1,y} + \phi_{s2,y} + \phi_{s3,y} = 0.00069813$$

$$\phi_{s1,y} (\text{column 1}) = (A_{s1} * h_1 / s_{h1}) / A_c = 0.00034907$$

$$h_1 = 250.00$$

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

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

$$\phi_{s2,y} (\text{column 2}) = (A_{s2} * h_2 / s_{h2}) / A_c = 0.00034907$$

$$h_2 = 250.00$$

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

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

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

$$h_3 = 250.00$$

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

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

$$A_{sec} = 750000.00$$

$$s_{h1} = 150.00$$

$$s_{h2} = 150.00$$

$$s_{h3} = 200.00$$

$$f_{ywe} = 625.00$$

$$f_{ce} = 20.00$$

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

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

$$y_1 = 0.00084854$$

$$s_{h1} = 0.00271532$$

$$f_{t1} = 254.5614$$

$$f_{y1} = 212.1345$$


```

su1 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb,min)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb,min)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 212.1345
with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb,min)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04026409
2 = Asl,com/(b*d)*(fs2/fc) = 0.04026409
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) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04801038
2 = Asl,com/(b*d)*(fs2/fc) = 0.04801038
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) = 0.23343312
Mu = MRc (4.14) = 8.8591E+007
u = su (4.1) = 1.7029732E-005

```

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$

$l_b = 300.00$

$l_d = 2120.262$

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

l_d, \min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$= 1$

$db = 16.85714$

Mean strength value of all re-bars: $f_y = 625.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of μ_2

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

$\mu = 1.7245646E-005$

$\mu_u = 1.0758E+008$

with full section properties:

$b = 3000.00$

$d = 208.00$

$d' = 42.00$

$v = 0.00220465$

$N = 27514.027$

$f_c = 20.00$

α (5A.5, TBDY) = 0.002

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.0035$

The Shear_factor is considered equal to 1 (pure moment strength)

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

w_e (5.4c) = 0.00

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

$a_{se1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$a_{se2} = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

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

$p_{sh, \min} = \text{Min}(p_{sh, x}, p_{sh, y}) = 0.00069813$

$p_{sh, x} = p_{s1, x} + p_{s2, x} + p_{s3, x} = 0.00356047$

$p_{s1, x}$ (column 1) = $(A_{s1} * h_1 / s_1) / A_c = 0.00083776$

$h_1 = 600.00$

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

No stirups, $n_{s1} = 2.00$

$p_{s2, x}$ (column 2) = $(A_{s2} * h_2 / s_2) / A_c = 0.00083776$

$h_2 = 600.00$

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

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, $n_{s3} = 2.00$

```

psh,y = ps1,y+ps2,y+ps3,y = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
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 = 150.00

```

```

s_2 = 150.00

```

```

s_3 = 200.00

```

```

fywe = 625.00

```

```

fce = 20.00

```

```

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

```

```

c = confinement factor = 1.00

```

```

y1 = 0.00084854

```

```

sh1 = 0.00271532

```

```

ft1 = 254.5614

```

```

fy1 = 212.1345

```

```

su1 = 0.00271532

```

```

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

```

```

lo/lou,min = lb/ld = 0.14149197

```

```

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

```

```

From table 5A.1, TBDY: esu1_nominal = 0.08,

```

```

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

```

```

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

```

```

with fs1 = fs = 212.1345

```

```

with Es1 = Es = 200000.00

```

```

y2 = 0.00084854

```

```

sh2 = 0.00271532

```

```

ft2 = 254.5614

```

```

fy2 = 212.1345

```

```

su2 = 0.00271532

```

```

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

```

```

lo/lou,min = lb/lb,min = 0.14149197

```

```

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

```

```

From table 5A.1, TBDY: esu2_nominal = 0.08,

```

```

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

```

```

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

```

```

with fs2 = fs = 212.1345

```

```

with Es2 = Es = 200000.00

```

```

yv = 0.00084854

```

```

shv = 0.00271532

```

```

ftv = 254.5614

```

```

fyv = 212.1345

```

```

suv = 0.00271532

```

```

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

```

```

lo/lou,min = lb/ld = 0.14149197

```

```

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

```

```

From table 5A.1, TBDY: esuv_nominal = 0.08,

```

```

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

```

For calculation of $e_{suv_nominal}$ and y_v , sh_v , ft_v , fy_v , it is considered characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.

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

with $f_{sv} = f_s = 212.1345$

with $E_{sv} = E_s = 200000.00$

$1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.04026409$

$2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.04026409$

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.02734113$

and confined core properties:

$b = 2940.00$

$d = 178.00$

$d' = 12.00$

f_{cc} (5A.2, TBDY) = 20.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

$1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.04801038$

$2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.04801038$

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.03260121$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.24303049

$\mu_u = M_{Rc}$ (4.14) = 1.0758E+008

$u = su$ (4.1) = 1.7245646E-005

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$

$l_b = 300.00$

$l_d = 2120.262$

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

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$db = 16.85714$

Mean strength value of all re-bars: $f_y = 625.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 834708.585$

Calculation of Shear Strength at edge 1, $V_{r1} = 834708.585$

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: $V_c = 729988.83$

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

= 1 (normal-weight concrete)

$f'_c = 20.00$, but $f'_c \cdot 0.5 \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$\mu_u = 3.9108324E-011$

$V_u = 4.7331654E-030$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 104719.755$

Vs1 = 52359.878 is calculated for pseudo-Column 1, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 500.00$
Vs1 has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
Vs2 = 52359.878 is calculated for pseudo-Column 2, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 500.00$
Vs2 has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
Vs3 = 0.00 is calculated for web, with:
 $d = 200.00$
 $A_v = 0.00$
 $s = 200.00$
 $f_y = 500.00$
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: $V_s + V_f \leq 1.7825E+006$
 $b_w = 3000.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 834708.585$
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: $V_c = 729988.83$
 $\mu_u / V_u - l_w / 2 = 0.00 \leq 0$
= 1 (normal-weight concrete)
 $f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3 \text{ MPa}$ (22.5.3.1, ACI 318-14)
 $h = 3000.00$
 $d = 200.00$
 $l_w = 250.00$
 $\mu_u = 3.9108324E-011$
 $V_u = 4.7331654E-030$
 $N_u = 27514.027$
From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 104719.755$
Vs1 = 52359.878 is calculated for pseudo-Column 1, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 500.00$
Vs1 has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
Vs2 = 52359.878 is calculated for pseudo-Column 2, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 500.00$
Vs2 has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
Vs3 = 0.00 is calculated for web, with:
 $d = 200.00$
 $A_v = 0.00$
 $s = 200.00$
 $f_y = 500.00$
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: $V_s + V_f \leq 1.7825E+006$
 $b_w = 3000.00$

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: (d)
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
 $n = 0.00069813$

with $n = ps1 + ps2 + ps3$, being the shear reinf. ratio in a plane perpendicular to the shear axis 3
(pseudo-col.1 $ps1 = As1*b1/s1 = (As1*h1/s1) / Ac = 0.00034907$
 $h1 = 250.00$
 $s1 = 150.00$
total area of hoops perpendicular to shear axis, $As1 = 157.0796$
(pseudo-col.2 $ps2 = As2*b2/s2 = (As2*h2/s2) / Ac = 0.00034907$
 $h2 = 250.00$
 $s2 = 150.00$
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:

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$
New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$
Concrete Elasticity, $E_c = 25742.96$
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
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_b = 300.00$
No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 525745.339$
Shear Force, $V2 = -1.8122959E-014$
Shear Force, $V3 = 19169.48$
Axial Force, $F = -29697.588$
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: $As_{l,mid} = 615.7522$

Mean Diameter of Tension Reinforcement, $DbL = 17.33333$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.00240492$
 $u = y + p = 0.00240492$

- Calculation of y -

$$y = (My \cdot I_p) / (EI)_{Eff} = 0.00040492 \text{ ((10-5), ASCE 41-17)}$$
$$My = 1.7102E+009$$
$$(EI)_{Eff} = 0.35 \cdot Ec \cdot I \text{ (table 10-5)}$$
$$Ec \cdot I = 1.4480E+016$$
$$I_p = 0.5 \cdot d = 0.5 \cdot (0.8 \cdot h) = 1200.00$$

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

$$y = \text{Min}(y_{ten}, y_{com})$$
$$y_{ten} = 4.1963465E-007$$
$$\text{with ((10.1), ASCE 41-17) } fy = \text{Min}(fy, 1.25 \cdot fy \cdot (lb/d)^{2/3}) = 196.9282$$
$$d = 2957.00$$
$$y = 0.20648484$$
$$A = 0.0087884$$
$$B = 0.00455861$$
$$\text{with } pt = 0.00387573$$
$$pc = 0.00387573$$
$$pv = 0.00083294$$
$$N = 29697.588$$
$$b = 250.00$$
$$" = 0.01454177$$
$$y_{comp} = 2.3333296E-006$$
$$\text{with } fc = 20.00$$
$$Ec = 25742.96$$
$$y = 0.20268266$$
$$A = 0.00844077$$
$$B = 0.00435462$$
$$\text{with } Es = 200000.00$$

Calculation of ratio lb/d

$$\text{Lap Length: } ld/d, \text{min} = 0.17686496$$
$$lb = 300.00$$
$$ld = 1696.209$$
$$\text{Calculation of } l \text{ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.}$$
$$ld, \text{min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)}$$
$$= 1$$
$$db = 16.85714$$
$$\text{Mean strength value of all re-bars: } fy = 500.00$$
$$t = 1.00$$
$$s = 0.80$$
$$e = 1.00$$
$$cb = 25.00$$
$$Ktr = 2.24399$$
$$n = 28.00$$

- Calculation of p -

Considering wall controlled by flexure (shear control ratio ≤ 1),

from table 10-19: $p = 0.002$

with:

- Condition i (shear wall and wall segments)

- $(A_s - A_s') \cdot f_y + P / (t_w \cdot l_w \cdot f_c') = -0.20955407$

$A_s = 0.00$

$A_s' = 6346.017$

$f_y = 500.00$

$P = 29697.588$

$t_w = 250.00$

$l_w = 3000.00$

$f_c = 20.00$

- $V / (t_w \cdot l_w \cdot f_c^{0.5}) = 0.06882676$, NOTE: units in lb & in

- Confined Boundary: No

Boundary hoops spacing exceed $8d_b$ ($s_1 > 8 \cdot d_b$ or $s_2 > 8 \cdot d_b$)

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:

$V_{w1} = 251327.412$

$s_1 = 150.00$

Boundary Element 2:

$V_{w2} = 251327.412$

$s_2 = 150.00$

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

Concrete Shear Force, $V_c = 730425.542$

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

Mean diameter of all bars, $d_b = 17.33333$

Design Shear Force, $V = 19169.48$

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

At local axis: 2

Integration Section: (d)

Calculation No. 7

wall W1, Floor 1

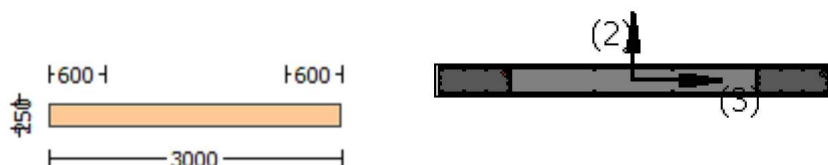
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

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: (d)

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, ASCE 41-17.

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

Consequently:

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

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

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = l_b = 300.00$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 5.6994E+007$

Shear Force, $V_a = -19169.48$

EDGE -B-

Bending Moment, $M_b = 525745.339$

Shear Force, $V_b = 19169.48$

BOTH EDGES

Axial Force, $F = -29697.588$

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, $Db_{L,ten} = 17.33333$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 1.7986E+006$
From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d = 1.7986E+006$

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: $V_c = 730425.542$

$\mu_u / \mu_u - l_w / 2 = -1472.574 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 525745.339$

$V_u = 19169.48$

$N_u = 29697.588$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0681E+006$

$V_{s1} = 251327.412$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

$V_{s2} = 251327.412$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

$V_{s3} = 565486.678$ is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 500.00$

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: $V_s + V_f \leq 1.7825E+006$

$b_w = 250.00$

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

At local axis: 3

Integration Section: (d)

Calculation No. 8

wall W1, Floor 1

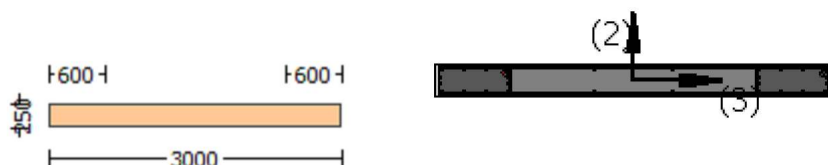
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (μ)

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:

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

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

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

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 625.00$

#####

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

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = 300.00$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 2.0194839E-028$

EDGE -B-

Shear Force, $V_b = -2.0194839E-028$

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 , $V_e/V_r = 0.68720049$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 1.2357E+006$ with

$M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 1.8535E+009$

$\mu_{u1+} = 1.7546E+009$, 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

$\mu_{u1-} = 1.8535E+009$, 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

$M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 1.8535E+009$

$\mu_{u2+} = 1.7546E+009$, 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

$\mu_{u2-} = 1.8535E+009$, 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 μ_{u1+}

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

$\mu_u = 1.1650088E-006$

$\mu_u = 1.7546E+009$

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$

$v = 0.00186094$

$N = 27514.027$

$f_c = 20.00$

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

Final value of ϕ_{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: $\phi_{cu} = 0.0035$

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

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

$\phi_{ase1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$\phi_{ase2} = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

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

$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.00069813$

$\phi_{psh,x} = \phi_{ps1,x} + \phi_{ps2,x} + \phi_{ps3,x} = 0.00356047$

$\phi_{ps1,x} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$

$h_1 = 600.00$

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

No stirups, $n_{s1} = 2.00$

$\phi_{ps2,x} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$

$h_2 = 600.00$

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

No stirups, $n_{s2} = 2.00$

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

$h_3 = 1800.00$

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

No stirups, $n_{s3} = 2.00$

```

psh,y = ps1,y+ps2,y+ps3,y = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
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 = 150.00

```

```

s_2 = 150.00

```

```

s_3 = 200.00

```

```

fywe = 625.00

```

```

fce = 20.00

```

```

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

```

```

c = confinement factor = 1.00

```

```

y1 = 0.00084854

```

```

sh1 = 0.00271532

```

```

ft1 = 254.5614

```

```

fy1 = 212.1345

```

```

su1 = 0.00271532

```

```

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

```

```

lo/lou,min = lb/ld = 0.14149197

```

```

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

```

```

From table 5A.1, TBDY: esu1_nominal = 0.08,

```

```

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

```

```

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

```

```

with fs1 = fs = 212.1345

```

```

with Es1 = Es = 200000.00

```

```

y2 = 0.00084854

```

```

sh2 = 0.00271532

```

```

ft2 = 254.5614

```

```

fy2 = 212.1345

```

```

su2 = 0.00271532

```

```

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

```

```

lo/lou,min = lb/lb,min = 0.14149197

```

```

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

```

```

From table 5A.1, TBDY: esu2_nominal = 0.08,

```

```

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

```

```

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

```

```

with fs2 = fs = 212.1345

```

```

with Es2 = Es = 200000.00

```

```

yv = 0.00084854

```

```

shv = 0.00271532

```

```

ftv = 254.5614

```

```

fyv = 212.1345

```

```

suv = 0.00271532

```

```

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

```

```

lo/lou,min = lb/ld = 0.14149197

```

```

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

```

```

From table 5A.1, TBDY: esuv_nominal = 0.08,

```

```

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

```

For calculation of $\epsilon_{sv_nominal}$ and γ_v , δ_v , f_{tv} , f_{yv} , it is considered characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.

γ_1 , δ_1 , f_{t1} , f_{y1} , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $f_{sv} = f_s = 212.1345$

with $E_{sv} = E_s = 200000.00$

$1 = A_{s1,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.04110878$

$2 = A_{s1,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.04110878$

$v = A_{s1,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$

and confined core properties:

$b = 190.00$

$d = 2927.00$

$d' = 13.00$

f_{cc} (5A.2, TBDY) = 20.00

ρ_c (5A.5, TBDY) = 0.002

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

$1 = A_{s1,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.0546449$

$2 = A_{s1,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.0546449$

$v = A_{s1,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

μ_u (4.9) = 0.21179234

$\mu_u = M_{Rc}$ (4.14) = 1.7546E+009

$u = \mu_u$ (4.1) = 1.1650088E-006

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$

$l_b = 300.00$

$l_d = 2120.262$

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

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$\delta_b = 16.85714$

Mean strength value of all re-bars: $f_y = 625.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$c_b = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of μ_{u1} -

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

$u = 1.1680845E-006$

$\mu_u = 1.8535E+009$

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$

$v = 0.00186094$

$N = 27514.027$

$f_c = 20.00$

ρ_c (5A.5, TBDY) = 0.002

Final value of μ_u : $\mu_u^* = \text{shear_factor} \cdot \text{Max}(\mu_u, \rho_c) = 0.0035$

The Shear_factor is considered equal to 1 (pure moment strength)

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

μ_u (5.4c) = 0.00

$$ase((5.4d), TBDY) = (ase1 \cdot Acol1 + ase2 \cdot Acol2 + ase3 \cdot Aweb) / Asec = 0.00$$

$$ase1 = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$ase2 = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

$$psh,min = \text{Min}(psh,x, psh,y) = 0.00069813$$

$$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$$

$$ps1,x \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00083776$$

$$h1 = 600.00$$

$$As1 = Astir1 \cdot ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2,x \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00083776$$

$$h2 = 600.00$$

$$As2 = Astir2 \cdot ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3,x \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00188496$$

$$h3 = 1800.00$$

$$As3 = Astir3 \cdot ns3 = 0.00$$

$$\text{No stirups, } ns3 = 2.00$$

$$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$$

$$ps1,y \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00034907$$

$$h1 = 250.00$$

$$As1 = Astir1 \cdot ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00034907$$

$$h2 = 250.00$$

$$As2 = Astir2 \cdot ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

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

$$h3 = 250.00$$

$$As3 = Astir3 \cdot ns3 = 157.0796$$

$$\text{No stirups, } ns3 = 0.00$$

$$Asec = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$fywe = 625.00$$

$$fce = 20.00$$

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

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

$$y1 = 0.00084854$$

$$sh1 = 0.00271532$$

$$ft1 = 254.5614$$

$$fy1 = 212.1345$$

$$su1 = 0.00271532$$

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

$$lo/lo,min = lb/ld = 0.14149197$$

$$su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu1_nominal = 0.08,$$

For calculation of esu1_nominal and y1, sh1, ft1, fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

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

$$\text{with } fs1 = fs = 212.1345$$

$$\text{with } Es1 = Es = 200000.00$$

$$y2 = 0.00084854$$

```

sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.14149197
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = fs = 212.1345
    with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.14149197
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = fs = 212.1345
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04110878
2 = Asl,com/(b*d)*(fs2/fc) = 0.04110878
v = Asl,mid/(b*d)*(fsv/fc) = 0.00883478
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0546449
2 = Asl,com/(b*d)*(fs2/fc) = 0.0546449
v = Asl,mid/(b*d)*(fsv/fc) = 0.01174386
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.21386777
Mu = MRc (4.14) = 1.8535E+009
u = su (4.1) = 1.1680845E-006

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.14149197
lb = 300.00
ld = 2120.262
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 625.00
t = 1.00
s = 0.80

```


e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

Calculation of Mu2+

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

$\phi_u = 1.1650088E-006$
 $M_u = 1.7546E+009$

with full section properties:

b = 250.00
d = 2957.00
d' = 43.00
v = 0.00186094
N = 27514.027

fc = 20.00
co (5A.5, TBDY) = 0.002

Final value of ϕ_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: $\phi_u = 0.0035$

we (5.4c) = 0.00

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

ase1 = 0.00

sh_1 = 150.00

bo_1 = 190.00

ho_1 = 540.00

bi2_1 = 655400.00

ase2 = 0.00

sh_2 = 150.00

bo_2 = 190.00

ho_2 = 540.00

bi2_2 = 655400.00

ase3 = 0 (grid does not provide confinement)

psh,min = $\text{Min}(psh,x, psh,y) = 0.00069813$

psh,x = $ps1,x + ps2,x + ps3,x = 0.00356047$

ps1,x (column 1) = $(As1 * h1 / s_1) / A_c = 0.00083776$

h1 = 600.00

As1 = $A_{stir1} * n_{s1} = 157.0796$

No stirups, ns1 = 2.00

ps2,x (column 2) = $(As2 * h2 / s_2) / A_c = 0.00083776$

h2 = 600.00

As2 = $A_{stir2} * n_{s2} = 157.0796$

No stirups, ns2 = 2.00

ps3,x (web) = $(As3 * h3 / s_3) / A_c = 0.00188496$

h3 = 1800.00

As3 = $A_{stir3} * n_{s3} = 0.00$

No stirups, ns3 = 2.00

psh,y = $ps1,y + ps2,y + ps3,y = 0.00069813$

ps1,y (column 1) = $(As1 * h1 / s_1) / A_c = 0.00034907$

h1 = 250.00

As1 = $A_{stir1} * n_{s1} = 157.0796$

No stirups, ns1 = 2.00

ps2,y (column 2) = $(As2 * h2 / s_2) / A_c = 0.00034907$

h2 = 250.00

As2 = $A_{stir2} * n_{s2} = 157.0796$

No stirups, ns2 = 2.00

ps3,y (web) = $(As3 * h3 / s_3) / A_c = 0.00$

h3 = 250.00

As3 = $A_{stir3} * n_{s3} = 157.0796$

No stirrups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 625.00

fce = 20.00

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

c = confinement factor = 1.00

y1 = 0.00084854

sh1 = 0.00271532

ft1 = 254.5614

fy1 = 212.1345

su1 = 0.00271532

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

lo/lou,min = lb/ld = 0.14149197

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

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

with fs1 = fs = 212.1345

with Es1 = Es = 200000.00

y2 = 0.00084854

sh2 = 0.00271532

ft2 = 254.5614

fy2 = 212.1345

su2 = 0.00271532

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

lo/lou,min = lb/lb,min = 0.14149197

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

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

with fs2 = fs = 212.1345

with Es2 = Es = 200000.00

yv = 0.00084854

shv = 0.00271532

ftv = 254.5614

fyv = 212.1345

suv = 0.00271532

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

lo/lou,min = lb/ld = 0.14149197

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

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

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

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

with fsv = fs = 212.1345

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.04110878

2 = Asl,com/(b*d)*(fs2/fc) = 0.04110878

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) = 20.00

```

cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0546449
2 = Asl,com/(b*d)*(fs2/fc) = 0.0546449
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) = 0.21179234
Mu = MRc (4.14) = 1.7546E+009
u = su (4.1) = 1.1650088E-006

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.14149197
lb = 300.00
ld = 2120.262
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 625.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

```

Calculation of Mu2-

```

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.1680845E-006
Mu = 1.8535E+009

```

with full section properties:

```

b = 250.00
d = 2957.00
d' = 43.00
v = 0.00186094
N = 27514.027
fc = 20.00
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 = 150.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 150.00
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) = 0.00069813

```

```

psh,x = ps1,x+ps2,x+ps3,x = 0.00356047
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00083776
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776
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 = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
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 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 625.00
fce = 20.00

```

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

```

y1 = 0.00084854
sh1 = 0.00271532
ft1 = 254.5614
fy1 = 212.1345
su1 = 0.00271532

```

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

lo/lou,min = lb/lb,min = 0.14149197

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb,min)^ 2/3), from 10.3.5, ASCE 41-17.

with fs1 = fs = 212.1345

with Es1 = Es = 200000.00

```

y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532

```

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

lo/lou,min = lb/lb,min = 0.14149197

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb,min)^ 2/3), from 10.3.5, ASCE 41-17.

```

with fs2 = fs = 212.1345
with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04110878
2 = Asl,com/(b*d)*(fs2/fc) = 0.04110878
v = Asl,mid/(b*d)*(fsv/fc) = 0.00883478
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0546449
2 = Asl,com/(b*d)*(fs2/fc) = 0.0546449
v = Asl,mid/(b*d)*(fsv/fc) = 0.01174386
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.21386777
Mu = MRc (4.14) = 1.8535E+009
u = su (4.1) = 1.1680845E-006

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.14149197
lb = 300.00
ld = 2120.262
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 625.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

```

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 1.7981\text{E}+006$

Calculation of Shear Strength at edge 1, $V_{r1} = 1.7981\text{E}+006$
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: $V_c = 729988.83$

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

= 1 (normal-weight concrete)

$f'_c = 20.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 1.6689249E-009$

$V_u = 2.0194839E-028$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0681E+006$

$V_{s1} = 251327.412$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

$V_{s2} = 251327.412$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

$V_{s3} = 565486.678$ is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 500.00$

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: $V_s + V_f \leq 1.7825E+006$

$b_w = 250.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 1.7981E+006$

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

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: $V_c = 729988.83$

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

= 1 (normal-weight concrete)

$f'_c = 20.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 1.6689249E-009$

$V_u = 2.0194839E-028$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0681E+006$

$V_{s1} = 251327.412$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

$V_{s2} = 251327.412$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

$V_{s3} = 565486.678$ is calculated for web, with:

$d = 1440.00$

Av = 157079.633

s = 200.00

fy = 500.00

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 <= 1.7825E+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:

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

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

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

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 625.00$

#####

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

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = 300.00$

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = -4.7331654E-030$

EDGE -B-

Shear Force, $V_b = 4.7331654E-030$

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: $As_{t,ten} = 2368.761$

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

-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 , $V_e/V_r = 0.08592175$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 71719.625$
 with
 $M_{pr1} = \text{Max}(Mu_{1+} , Mu_{1-}) = 1.0758E+008$
 $Mu_{1+} = 8.8591E+007$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
 which is defined for the static loading combination
 $Mu_{1-} = 1.0758E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment
 direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(Mu_{2+} , Mu_{2-}) = 1.0758E+008$
 $Mu_{2+} = 8.8591E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
 which is defined for the the static loading combination
 $Mu_{2-} = 1.0758E+008$, 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_{1+}

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

$$\phi_u = 1.7029732E-005$$

$$M_u = 8.8591E+007$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00220465$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_o) = 0.0035$$

The Shear_factor is considered equal to 1 (pure moment strength)

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

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

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

$$\phi_{ase1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$\phi_{ase2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

$$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.00069813$$

$$\phi_{psh,x} = \phi_{ps1,x} + \phi_{ps2,x} + \phi_{ps3,x} = 0.00356047$$

$$\phi_{ps1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

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

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

$$\phi_{ps2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

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

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

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

$$h_3 = 1800.00$$

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

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

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 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

$s_1 = 150.00$

$s_2 = 150.00$

$s_3 = 200.00$

$fywe = 625.00$

$fce = 20.00$

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

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

$y1 = 0.00084854$

$sh1 = 0.00271532$

$ft1 = 254.5614$

$fy1 = 212.1345$

$su1 = 0.00271532$

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

$lo/lou,min = lb/ld = 0.14149197$

$su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

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

with $fs1 = fs = 212.1345$

with $Es1 = Es = 200000.00$

$y2 = 0.00084854$

$sh2 = 0.00271532$

$ft2 = 254.5614$

$fy2 = 212.1345$

$su2 = 0.00271532$

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

$lo/lou,min = lb/lb,min = 0.14149197$

$su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

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

with $fs2 = fs = 212.1345$

with $Es2 = Es = 200000.00$

$yv = 0.00084854$

$shv = 0.00271532$

$ftv = 254.5614$

$fyv = 212.1345$

$suv = 0.00271532$

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

$lo/lou,min = lb/ld = 0.14149197$

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

From table 5A.1, TBDY: $esuv_nominal = 0.08$,

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

characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = f_s = 212.1345$
 with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.04026409$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.04026409$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$

and confined core properties:

$b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} \text{ (5A.2, TBDY)} = 20.00$
 $cc \text{ (5A.5, TBDY)} = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.04801038$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.04801038$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su \text{ (4.9)} = 0.23343312$
 $Mu = MR_c \text{ (4.14)} = 8.8591E+007$
 $u = su \text{ (4.1)} = 1.7029732E-005$

 Calculation of ratio l_b/l_d

 Lap Length: $l_b/l_d = 0.14149197$

$l_b = 300.00$
 $l_d = 2120.262$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $f_y = 625.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

 Calculation of Mu_1 -

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

$u = 1.7245646E-005$
 $Mu = 1.0758E+008$

 with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00220465$
 $N = 27514.027$
 $f_c = 20.00$
 $co \text{ (5A.5, TBDY)} = 0.002$
 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: $cu = 0.0035$
 $we \text{ (5.4c)} = 0.00$
 $ase \text{ ((5.4d), TBDY)} = (ase_1 \cdot A_{col1} + ase_2 \cdot A_{col2} + ase_3 \cdot A_{web}) / A_{sec} = 0.00$

```

ase1 = 0.00
sh_1 = 150.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 150.00
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) = 0.00069813

```

```

psh,x = ps1,x+ps2,x+ps3,x = 0.00356047
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00083776
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776
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 = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
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 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 625.00
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00084854
sh1 = 0.00271532
ft1 = 254.5614
fy1 = 212.1345
su1 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532

```

```

ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.14149197
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = fs = 212.1345
    with Es2 = Es = 200000.00
    yv = 0.00084854
    shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 0.14149197
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = fs = 212.1345
    with Esv = Es = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.04026409
    2 = Asl,com/(b*d)*(fs2/fc) = 0.04026409
    v = Asl,mid/(b*d)*(fsv/fc) = 0.02734113
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.04801038
    2 = Asl,com/(b*d)*(fs2/fc) = 0.04801038
    v = Asl,mid/(b*d)*(fsv/fc) = 0.03260121

```

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

```

---->
v < vs,y2 - LHS eq.(4.5) is satisfied
---->
su (4.9) = 0.24303049
Mu = MRc (4.14) = 1.0758E+008
u = su (4.1) = 1.7245646E-005

```

Calculation of ratio lb/lb

```

Lap Length: lb/lb = 0.14149197
lb = 300.00
lb = 2120.262
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
lb,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 625.00
t = 1.00
s = 0.80
e = 1.00

```

cb = 25.00
Ktr = 2.24399
n = 28.00

Calculation of Mu2+

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

$\phi_u = 1.7029732E-005$
 $M_u = 8.8591E+007$

with full section properties:

b = 3000.00
d = 208.00
d' = 42.00
 $\nu = 0.00220465$
N = 27514.027

$f_c = 20.00$

co (5A.5, TBDY) = 0.002

Final value of ϕ_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: $\phi_u = 0.0035$

$\phi_{ue} = 0.00$

$\phi_{ue}((5.4d), \text{TBDY}) = (\phi_{ue1} * A_{col1} + \phi_{ue2} * A_{col2} + \phi_{ue3} * A_{web}) / A_{sec} = 0.00$

$\phi_{ue1} = 0.00$

sh_1 = 150.00

bo_1 = 190.00

ho_1 = 540.00

bi2_1 = 655400.00

$\phi_{ue2} = 0.00$

sh_2 = 150.00

bo_2 = 190.00

ho_2 = 540.00

bi2_2 = 655400.00

$\phi_{ue3} = 0$ (grid does not provide confinement)

$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00069813$

$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00356047$

$\phi_{s1,x} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$

h1 = 600.00

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

No stirups, $n_{s1} = 2.00$

$\phi_{s2,x} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$

h2 = 600.00

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

No stirups, $n_{s2} = 2.00$

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

h3 = 1800.00

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

No stirups, $n_{s3} = 2.00$

$\phi_{sh,y} = \phi_{s1,y} + \phi_{s2,y} + \phi_{s3,y} = 0.00069813$

$\phi_{s1,y} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$

h1 = 250.00

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

No stirups, $n_{s1} = 2.00$

$\phi_{s2,y} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$

h2 = 250.00

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

No stirups, $n_{s2} = 2.00$

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

h3 = 250.00

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

No stirups, $n_{s3} = 0.00$

```

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 625.00
fce = 20.00
From ((5.A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00084854
sh1 = 0.00271532
ft1 = 254.5614
fy1 = 212.1345
su1 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 212.1345
with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04026409
2 = Asl,com/(b*d)*(fs2/fc) = 0.04026409
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) = 20.00
cc (5A.5, TBDY) = 0.002

```

```

c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04801038
2 = Asl,com/(b*d)*(fs2/fc) = 0.04801038
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) = 0.23343312
Mu = MRc (4.14) = 8.8591E+007
u = su (4.1) = 1.7029732E-005

```

Calculation of ratio lb/d

```

Lap Length: lb/d = 0.14149197
lb = 300.00
ld = 2120.262
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 625.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

```

Calculation of Mu2-

```

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.7245646E-005
Mu = 1.0758E+008

```

with full section properties:

```

b = 3000.00
d = 208.00
d' = 42.00
v = 0.00220465
N = 27514.027
fc = 20.00
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 = 150.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 150.00
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) = 0.00069813

```

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,x \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 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, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 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, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 625.00$
 $fce = 20.00$

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

$y1 = 0.00084854$
 $sh1 = 0.00271532$
 $ft1 = 254.5614$
 $fy1 = 212.1345$
 $su1 = 0.00271532$

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

$lo/lou,min = lb/ld = 0.14149197$
 $su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

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

with $fs1 = fs = 212.1345$
 with $Es1 = Es = 200000.00$

$y2 = 0.00084854$
 $sh2 = 0.00271532$
 $ft2 = 254.5614$
 $fy2 = 212.1345$
 $su2 = 0.00271532$

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

$lo/lou,min = lb/lb,min = 0.14149197$
 $su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

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

with $fs2 = fs = 212.1345$

with $E_s = E_s = 200000.00$
 $y_v = 0.00084854$
 $sh_v = 0.00271532$
 $ft_v = 254.5614$
 $fy_v = 212.1345$
 $suv = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lo_{min} = lb/ld = 0.14149197$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fs_v = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fs_v = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 212.1345$
 with $E_s = E_s = 200000.00$
 $1 = A_{sl,ten}/(b*d) * (fs_1/fc) = 0.04026409$
 $2 = A_{sl,com}/(b*d) * (fs_2/fc) = 0.04026409$
 $v = A_{sl,mid}/(b*d) * (fsv/fc) = 0.02734113$
 and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 20.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d) * (fs_1/fc) = 0.04801038$
 $2 = A_{sl,com}/(b*d) * (fs_2/fc) = 0.04801038$
 $v = A_{sl,mid}/(b*d) * (fsv/fc) = 0.03260121$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.14149197$
 $lb = 300.00$
 $ld = 2120.262$
 Calculation of lb_{min} according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 ld_{min} from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $fy = 625.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

Calculation of Shear Strength $V_r = Min(V_{r1}, V_{r2}) = 834708.585$

Calculation of Shear Strength at edge 1, $V_{r1} = 834708.585$
 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: $V_c = 729988.83$

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

= 1 (normal-weight concrete)

$f'_c = 20.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$M_u = 3.9108324E-011$

$V_u = 4.7331654E-030$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 104719.755$

$V_{s1} = 52359.878$ is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

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

$V_{s2} = 52359.878$ is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

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

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

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 500.00$

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: $V_s + V_f \leq 1.7825E+006$

$b_w = 3000.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 834708.585$

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

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: $V_c = 729988.83$

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

= 1 (normal-weight concrete)

$f'_c = 20.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$M_u = 3.9108324E-011$

$V_u = 4.7331654E-030$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 104719.755$

$V_{s1} = 52359.878$ is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

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

$V_{s2} = 52359.878$ is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

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

Vs3 = 0.00 is calculated for web, with:

$$d = 200.00$$

$$A_v = 0.00$$

$$s = 200.00$$

$$f_y = 500.00$$

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

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

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

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 1.7825E+006$$

$$b_w = 3000.00$$

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: (d)

Section Type: rcwrs

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

$$\gamma = 0.00069813$$

with $\gamma = \gamma_1 + \gamma_2 + \gamma_3$, being the shear reinf. ratio in a plane perpendicular to the shear axis 2

$$(\text{pseudo-col.1 } \gamma_1 = A_{s1} \cdot b_1 / s_1 = (A_{s1} \cdot h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

$$s_1 = 150.00$$

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

$$(\text{pseudo-col.2 } \gamma_2 = A_{s2} \cdot b_2 / s_2 = (A_{s2} \cdot h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

$$s_2 = 150.00$$

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

$$(\text{grid } \gamma_3 = A_{s3} \cdot b_3 / s_3 = (A_{s3} \cdot h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$s_3 = 200.00$$

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

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

Consequently:

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

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

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_b = 300.00$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = -3.5014360E-010$

Shear Force, $V2 = -1.8122959E-014$

Shear Force, $V3 = 19169.48$

Axial Force, $F = -29697.588$

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, $Db_L = 17.20$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.00276728$

$u = y + p = 0.00276728$

- Calculation of y -

$y = (M_y * I_p) / (EI)_{Eff} = 0.00076728$ ((10-5), ASCE 41-17))

$M_y = 1.1252E+008$

$(EI)_{Eff} = 0.35 * E_c * I$ (table 10-5)

$E_c * I = 1.0056E+014$

$I_p = 0.5 * d = 0.5 * (0.8 * h) = 240.00$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

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

$y_{ten} = 6.2580201E-006$

with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (I_b / I_d)^{2/3}) = 196.9282$

$d = 208.00$

$y = 0.24355457$

$A = 0.01041157$

$B = 0.00635339$

with $pt = 0.00379609$

$pc = 0.00379609$

$pv = 0.00257772$

$N = 29697.588$

$b = 3000.00$

$" = 0.20192308$

$y_{comp} = 2.7999955E-005$

with $fc = 20.00$

$E_c = 25742.96$

$y = 0.24011724$

$A = 0.00999974$

$B = 0.00611172$

with $Es = 200000.00$

Calculation of ratio I_b / I_d

Lap Length: $I_d / I_{d,min} = 0.17686496$

$I_b = 300.00$

$I_d = 1696.209$

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

$I_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)

$= 1$

db = 16.85714
Mean strength value of all re-bars: fy = 500.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

- Calculation of p -

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

with:

- Condition i (shear wall and wall segments)

- $(A_s - A_s') \cdot f_y + P) / (t_w \cdot l_w \cdot f_c') = -0.20955407$

As = 0.00

As' = 6346.017

fy = 500.00

P = 29697.588

tw = 3000.00

lw = 250.00

fc = 20.00

- $V / (t_w \cdot l_w \cdot f_c'^{0.5}) = 6.5069293E-020$, NOTE: units in lb & in

- Confined Boundary: No

Boundary hoops spacing exceed 8db ($s_1 > 8 \cdot db$ or $s_2 > 8 \cdot db$)

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:

Vw1 = 104719.755

s1 = 150.00

Boundary Element 2:

Vw2 = 104719.755

s2 = 150.00

Grid Shear Force, Vw3 = 0.00

Concrete Shear Force, Vc = 137720.649

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

Mean diameter of all bars, db = 17.33333

Design Shear Force, V = 1.8122959E-014

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

At local axis: 3

Integration Section: (d)

Calculation No. 9

wall W1, Floor 1

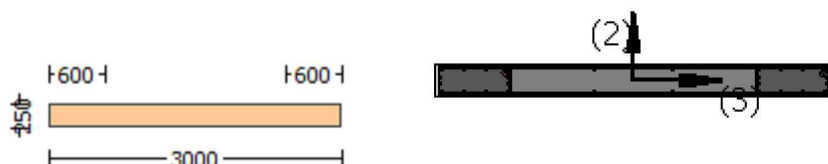
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VR_d

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, ASCE 41-17.

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

Consequently:

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

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

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = l_b = 300.00$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 6.2281024E-010$

Shear Force, $V_a = 2.8553711E-014$

EDGE -B-

Bending Moment, $M_b = -5.2916137E-010$

Shear Force, $V_b = -2.8553711E-014$

BOTH EDGES

Axial Force, $F = -30954.347$

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: $As_{l,com} = 2368.761$

-Middle: $As_{l,mid} = 1608.495$

Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 17.20$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 242034.135$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d = 242034.135$

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: $V_c = 137314.38$

$M_u/V_u - l_w/2 = 21686.884 > 0$

= 1 (normal-weight concrete)

$f_c' = 20.00$, but $f_c' \cdot 0.5 \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$M_u = 6.2281024E-010$

$V_u = 2.8553711E-014$

$N_u = 30954.347$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 104719.755$

$V_{s1} = 52359.878$ is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

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

$V_{s2} = 52359.878$ is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

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

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

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 500.00$

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: $V_s + V_f \leq 1.7825E+006$

$b_w = 3000.00$

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: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (μ)

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, $\gamma = 1.00$

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

Consequently:

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

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

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

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 625.00$

#####

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

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = 300.00$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 2.0194839E-028$

EDGE -B-

Shear Force, $V_b = -2.0194839E-028$

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 , $V_e/V_r = 0.68720049$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 1.2357E+006$ with

$M_{pr1} = \text{Max}(\mu_{1+}, \mu_{1-}) = 1.8535E+009$

$\mu_{1+} = 1.7546E+009$, 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

$\mu_{1-} = 1.8535E+009$, 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

$M_{pr2} = \text{Max}(\mu_{2+}, \mu_{2-}) = 1.8535E+009$

$\mu_{2+} = 1.7546E+009$, 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

$\mu_{2-} = 1.8535E+009$, 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 μ_{1+}

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

$\mu = 1.1650088E-006$

$M_u = 1.7546E+009$

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$

$v = 0.00186094$

$N = 27514.027$

$f_c = 20.00$

ϕ_c (5A.5, TBDY) = 0.002

Final value of ϕ_{cu} : $\phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_c) = 0.0035$

The Shear_factor is considered equal to 1 (pure moment strength)

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

ϕ_{we} (5.4c) = 0.00

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

$\phi_{ase1} = 0.00$

$\phi_{sh_1} = 150.00$

$\phi_{bo_1} = 190.00$

$\phi_{ho_1} = 540.00$

$\phi_{bi2_1} = 655400.00$

$\phi_{ase2} = 0.00$

```

sh_2 = 150.00
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) = 0.00069813

```

```

psh,x = ps1,x+ps2,x+ps3,x = 0.00356047
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00083776
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776
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 = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
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 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 625.00
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00084854
sh1 = 0.00271532
ft1 = 254.5614
fy1 = 212.1345
su1 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

```

$l_o/l_{o,min} = l_b/l_{b,min} = 0.14149197$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 212.1345$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00084854$
 $sh_v = 0.00271532$
 $ft_v = 254.5614$
 $fy_v = 212.1345$
 $suv = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 0.14149197$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 212.1345$
 with $Es_v = Es = 200000.00$
 $1 = A_{sl,ten}/(b*d)*(fs_1/f_c) = 0.04110878$
 $2 = A_{sl,com}/(b*d)*(fs_2/f_c) = 0.04110878$
 $v = A_{sl,mid}/(b*d)*(fsv/f_c) = 0.00$

and confined core properties:

$b = 190.00$
 $d = 2927.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 20.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d)*(fs_1/f_c) = 0.0546449$
 $2 = A_{sl,com}/(b*d)*(fs_2/f_c) = 0.0546449$
 $v = A_{sl,mid}/(b*d)*(fsv/f_c) = 0.00$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su (4.9) = 0.21179234$

$\mu_u = MR_c (4.14) = 1.7546E+009$

$u = su (4.1) = 1.1650088E-006$

 Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$

$l_b = 300.00$

$l_d = 2120.262$

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

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$db = 16.85714$

Mean strength value of all re-bars: $fy = 625.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of Mu1-

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

$$\phi_u = 1.1680845E-006$$

$$M_u = 1.8535E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00186094$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{co}) = 0.0035$$

The Shear_factor is considered equal to 1 (pure moment strength)

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

$$w_e (5.4c) = 0.00$$

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

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

$$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00069813$$

$$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00356047$$

$$\phi_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

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

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

$$\phi_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

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

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

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

$$h_3 = 1800.00$$

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

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

$$\phi_{sh,y} = \phi_{s1,y} + \phi_{s2,y} + \phi_{s3,y} = 0.00069813$$

$$\phi_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

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

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

$$\phi_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

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

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

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

$$h_3 = 250.00$$

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

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

$$A_{sec} = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 625.00$$

```

fce = 20.00
From ((5A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00084854
sh1 = 0.00271532
ft1 = 254.5614
fy1 = 212.1345
su1 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 212.1345
with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04110878
2 = Asl,com/(b*d)*(fs2/fc) = 0.04110878
v = Asl,mid/(b*d)*(fsv/fc) = 0.00883478
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0546449
2 = Asl,com/(b*d)*(fs2/fc) = 0.0546449
v = Asl,mid/(b*d)*(fsv/fc) = 0.01174386
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

```

```

--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.21386777
Mu = MRc (4.14) = 1.8535E+009
u = su (4.1) = 1.1680845E-006

```

Calculation of ratio lb/l_d

```

Lap Length: lb/ld = 0.14149197
lb = 300.00
ld = 2120.262
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 625.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

```

Calculation of Mu₂₊

```

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.1650088E-006
Mu = 1.7546E+009

```

with full section properties:

```

b = 250.00
d = 2957.00
d' = 43.00
v = 0.00186094
N = 27514.027
fc = 20.00
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 = 150.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 150.00
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) = 0.00069813

```

```

psh,x = ps1,x+ps2,x+ps3,x = 0.00356047
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00083776
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776

```

$h_2 = 600.00$
 $As_2 = Astir_2 * ns_2 = 157.0796$
 No stirups, $ns_2 = 2.00$
 $ps_{3,x} (web) = (As_3 * h_3 / s_3) / Ac = 0.00188496$
 $h_3 = 1800.00$
 $As_3 = Astir_3 * ns_3 = 0.00$
 No stirups, $ns_3 = 2.00$

$psh_y = ps_1_y + ps_2_y + ps_3_y = 0.00069813$
 $ps_1_y (column\ 1) = (As_1 * h_1 / s_1) / Ac = 0.00034907$
 $h_1 = 250.00$
 $As_1 = Astir_1 * ns_1 = 157.0796$
 No stirups, $ns_1 = 2.00$
 $ps_2_y (column\ 2) = (As_2 * h_2 / s_2) / Ac = 0.00034907$
 $h_2 = 250.00$
 $As_2 = Astir_2 * ns_2 = 157.0796$
 No stirups, $ns_2 = 2.00$
 $ps_3_y (web) = (As_3 * h_3 / s_3) / Ac = 0.00$
 $h_3 = 250.00$
 $As_3 = Astir_3 * ns_3 = 157.0796$
 No stirups, $ns_3 = 0.00$

$A_{sec} = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fy_{we} = 625.00$
 $f_{ce} = 20.00$
 From ((5.A.5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y_1 = 0.00084854$
 $sh_1 = 0.00271532$
 $ft_1 = 254.5614$
 $fy_1 = 212.1345$
 $su_1 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/ld = 0.14149197$
 $su_1 = 0.4 * esu_{1_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{1_nominal} = 0.08$,
 For calculation of $esu_{1_nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = fs = 212.1345$
 with $Es_1 = Es = 200000.00$
 $y_2 = 0.00084854$
 $sh_2 = 0.00271532$
 $ft_2 = 254.5614$
 $fy_2 = 212.1345$
 $su_2 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/lb, min = 0.14149197$
 $su_2 = 0.4 * esu_{2_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2_nominal} = 0.08$,
 For calculation of $esu_{2_nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2 / 1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 212.1345$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00084854$
 $sh_v = 0.00271532$
 $ft_v = 254.5614$
 $fy_v = 212.1345$
 $suv = 0.00271532$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.14149197$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_{nominal}$ and yv, shv, ftv, fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fsv = fs = 212.1345$
with $Esv = Es = 200000.00$
 $1 = Asl_{ten}/(b*d) * (fs1/fc) = 0.04110878$
 $2 = Asl_{com}/(b*d) * (fs2/fc) = 0.04110878$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.00$

and confined core properties:

$b = 190.00$
 $d = 2927.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 20.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_{ten}/(b*d) * (fs1/fc) = 0.0546449$
 $2 = Asl_{com}/(b*d) * (fs2/fc) = 0.0546449$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.00$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su (4.9) = 0.21179234$
 $Mu = MRc (4.14) = 1.7546E+009$
 $u = su (4.1) = 1.1650088E-006$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$

$l_b = 300.00$

$l_d = 2120.262$

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

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$db = 16.85714$

Mean strength value of all re-bars: $fy = 625.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of $Mu2$ -

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

$u = 1.1680845E-006$

$Mu = 1.8535E+009$

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$

$v = 0.00186094$

$N = 27514.027$
 $f_c = 20.00$
 $\alpha (5A.5, \text{TBDY}) = 0.002$
 Final value of α : $\alpha^* = \text{shear_factor} * \text{Max}(\alpha, \alpha_c) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\alpha = 0.0035$
 $\alpha_e (5.4c) = 0.00$
 $\alpha_e ((5.4d), \text{TBDY}) = (\alpha_{e1} * A_{col1} + \alpha_{e2} * A_{col2} + \alpha_{e3} * A_{web}) / A_{sec} = 0.00$
 $\alpha_{e1} = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $\alpha_{e2} = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $\alpha_{e3} = 0$ (grid does not provide confinement)
 $p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$
 $p_{s1,x} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$
 $h_1 = 600.00$
 $A_{s1} = A_{stir1} * n_{s1} = 157.0796$
 No stirups, $n_{s1} = 2.00$
 $p_{s2,x} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$
 $h_2 = 600.00$
 $A_{s2} = A_{stir2} * n_{s2} = 157.0796$
 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, $n_{s3} = 2.00$

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$
 $p_{s1,y} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$
 $h_1 = 250.00$
 $A_{s1} = A_{stir1} * n_{s1} = 157.0796$
 No stirups, $n_{s1} = 2.00$
 $p_{s2,y} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$
 $h_2 = 250.00$
 $A_{s2} = A_{stir2} * n_{s2} = 157.0796$
 No stirups, $n_{s2} = 2.00$
 $p_{s3,y} (\text{web}) = (A_{s3} * h_3 / s_3) / A_c = 0.00$
 $h_3 = 250.00$
 $A_{s3} = A_{stir3} * n_{s3} = 157.0796$
 No stirups, $n_{s3} = 0.00$

$A_{sec} = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $f_{ywe} = 625.00$
 $f_{ce} = 20.00$
 From ((5.A5), TBDY), TBDY: $\alpha_c = 0.002$
 $\alpha_c = \text{confinement factor} = 1.00$
 $y_1 = 0.00084854$
 $sh_1 = 0.00271532$
 $ft_1 = 254.5614$
 $fy_1 = 212.1345$
 $su_1 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o / l_{ou,min} = l_b / l_d = 0.14149197$
 $su_1 = 0.4 * esu_{1,nominal} ((5.5), \text{TBDY}) = 0.032$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,
For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs1 = fs = 212.1345$
with $Es1 = Es = 200000.00$
 $y2 = 0.00084854$
 $sh2 = 0.00271532$
 $ft2 = 254.5614$
 $fy2 = 212.1345$
 $su2 = 0.00271532$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $lo/lou, min = lb/lb, min = 0.14149197$
 $su2 = 0.4 \cdot esu2_nominal \cdot ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esu2_nominal = 0.08$,
For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs2 = fs = 212.1345$
with $Es2 = Es = 200000.00$
 $yv = 0.00084854$
 $shv = 0.00271532$
 $ftv = 254.5614$
 $fyv = 212.1345$
 $suv = 0.00271532$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $lo/lou, min = lb/ld = 0.14149197$
 $suv = 0.4 \cdot esuv_nominal \cdot ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esuv_nominal = 0.08$,
considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fsv = fs = 212.1345$
with $Esv = Es = 200000.00$
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.04110878$
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.04110878$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00883478$
and confined core properties:
 $b = 190.00$
 $d = 2927.00$
 $d' = 13.00$
 $fcc \text{ (5A.2, TBDY)} = 20.00$
 $cc \text{ (5A.5, TBDY)} = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.0546449$
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.0546449$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.01174386$
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
 $v < vs, y2$ - LHS eq.(4.5) is satisfied
--->
 $su \text{ (4.9)} = 0.21386777$
 $Mu = MRc \text{ (4.14)} = 1.8535E+009$
 $u = su \text{ (4.1)} = 1.1680845E-006$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.14149197$
 $lb = 300.00$
 $ld = 2120.262$

Calculation of l_b, \min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d, \min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 16.85714$
Mean strength value of all re-bars: $f_y = 625.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 1.7981E+006$

Calculation of Shear Strength at edge 1, $V_{r1} = 1.7981E+006$
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: $V_c = 729988.83$
 $\mu_u / \mu_u - l_w / 2 = 0.00 \leq 0$
 $= 1$ (normal-weight concrete)
 $f_c' = 20.00$, but $f_c' \cdot 0.5 \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 250.00$
 $d = 2400.00$
 $l_w = 3000.00$
 $\mu_u = 1.6689249E-009$
 $V_u = 2.0194839E-028$
 $N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0681E+006$

$V_{s1} = 251327.412$ is calculated for pseudo-Column 1, with:

$d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 500.00$

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

$V_{s2} = 251327.412$ is calculated for pseudo-Column 2, with:

$d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 500.00$

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

$V_{s3} = 565486.678$ is calculated for web, with:

$d = 1440.00$
 $A_v = 157079.633$
 $s = 200.00$
 $f_y = 500.00$

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: $V_s + V_f \leq 1.7825E+006$

$b_w = 250.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 1.7981E+006$

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: $V_c = 729988.83$
 $\mu_u / \mu_u - l_w / 2 = 0.00 \leq 0$
 $= 1$ (normal-weight concrete)
 $f_c' = 20.00$, but $f_c' \cdot 0.5 \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 250.00$

```

d = 2400.00
lw = 3000.00
Mu = 1.6689249E-009
Vu = 2.0194839E-028
Nu = 27514.027
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 + Vs3 = 1.0681E+006
Vs1 = 251327.412 is calculated for pseudo-Column 1, with:
d = 480.00
Av = 157079.633
s = 150.00
fy = 500.00
Vs1 has been multiplied by 1 (s<d/2, according to ASCE 41-17,10.3.4)
Vs2 = 251327.412 is calculated for pseudo-Column 2, with:
d = 480.00
Av = 157079.633
s = 150.00
fy = 500.00
Vs2 has been multiplied by 1 (s<d/2, according to ASCE 41-17,10.3.4)
Vs3 = 565486.678 is calculated for web, with:
d = 1440.00
Av = 157079.633
s = 200.00
fy = 500.00
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 <= 1.7825E+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:
New material of Primary Member: Concrete Strength, fc = fcm = 20.00
New material of Primary Member: Steel Strength, fs = fsm = 500.00
Concrete Elasticity, Ec = 25742.96
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
New material: Steel Strength, fs = 1.25*fsm = 625.00
#####
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
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

```

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = -4.7331654E-030$

EDGE -B-

Shear Force, $V_b = 4.7331654E-030$

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: $As_{t,ten} = 2368.761$

-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, $V_e/V_r = 0.08592175$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 71719.625$

with

$M_{pr1} = \text{Max}(\mu_{1+}, \mu_{1-}) = 1.0758E+008$

$\mu_{1+} = 8.8591E+007$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$\mu_{1-} = 1.0758E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

$M_{pr2} = \text{Max}(\mu_{2+}, \mu_{2-}) = 1.0758E+008$

$\mu_{2+} = 8.8591E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination

$\mu_{2-} = 1.0758E+008$, 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 μ_{1+}

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

$\mu = 1.7029732E-005$

$M_u = 8.8591E+007$

with full section properties:

$b = 3000.00$

$d = 208.00$

$d' = 42.00$

$v = 0.00220465$

$N = 27514.027$

$f_c = 20.00$

ϕ (5A.5, TBDY) = 0.002

Final value of ϕ : $\phi^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0035$

The Shear_factor is considered equal to 1 (pure moment strength)

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

ϕ_{we} (5.4c) = 0.00

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

$\phi_{ase1} = 0.00$

$\phi_{sh_1} = 150.00$

$\phi_{bo_1} = 190.00$

$\phi_{ho_1} = 540.00$

$\phi_{bi_1} = 655400.00$

$\phi_{ase2} = 0.00$

$\phi_{sh_2} = 150.00$

$bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $ase3 = 0$ (grid does not provide confinement)
 $psh,min = \text{Min}(psh,x, psh,y) = 0.00069813$

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x$ (column 1) = $(As1 \cdot h1 / s_1) / Ac = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,x$ (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirups, $ns2 = 2.00$
 $ps3,x$ (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00188496$
 $h3 = 1800.00$
 $As3 = Astir3 \cdot ns3 = 0.00$
 No stirups, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y$ (column 1) = $(As1 \cdot h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,y$ (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirups, $ns2 = 2.00$
 $ps3,y$ (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00$
 $h3 = 250.00$
 $As3 = Astir3 \cdot ns3 = 157.0796$
 No stirups, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 625.00$
 $fce = 20.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c =$ confinement factor = 1.00
 $y1 = 0.00084854$
 $sh1 = 0.00271532$
 $ft1 = 254.5614$
 $fy1 = 212.1345$
 $su1 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/ld = 0.14149197$
 $su1 = 0.4 \cdot esu1_nominal$ ((5.5), TBDY) = 0.032
 From table 5A.1, TBDY: $esu1_nominal = 0.08$,
 For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1 / 1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = fs = 212.1345$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00084854$
 $sh2 = 0.00271532$
 $ft2 = 254.5614$
 $fy2 = 212.1345$
 $su2 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/lb,min = 0.14149197$

$su_2 = 0.4 \cdot esu_{2_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2_nominal} = 0.08$,
 For calculation of $esu_{2_nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 212.1345$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00084854$
 $sh_v = 0.00271532$
 $ft_v = 254.5614$
 $fy_v = 212.1345$
 $suv = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lo_{u,min} = lb/ld = 0.14149197$
 $suv = 0.4 \cdot esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = fs = 212.1345$
 with $Es_v = Es = 200000.00$
 $1 = Asl_{ten}/(b \cdot d) \cdot (fs_1/fc) = 0.04026409$
 $2 = Asl_{com}/(b \cdot d) \cdot (fs_2/fc) = 0.04026409$
 $v = Asl_{mid}/(b \cdot d) \cdot (fs_v/fc) = 0.00$

and confined core properties:

$b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 20.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_{ten}/(b \cdot d) \cdot (fs_1/fc) = 0.04801038$
 $2 = Asl_{com}/(b \cdot d) \cdot (fs_2/fc) = 0.04801038$
 $v = Asl_{mid}/(b \cdot d) \cdot (fs_v/fc) = 0.00$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su (4.9) = 0.23343312$

$\mu_u = MR_c (4.14) = 8.8591E+007$

$u = su (4.1) = 1.7029732E-005$

 Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.14149197$

$lb = 300.00$

$ld = 2120.262$

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

ld_{min} from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$db = 16.85714$

Mean strength value of all re-bars: $fy = 625.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of μ_{u1} -

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

$$\phi_u = 1.7245646E-005$$

$$\mu = 1.0758E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$\nu = 0.00220465$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

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

The Shear_factor is considered equal to 1 (pure moment strength)

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

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

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

$$\phi_{ase1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$\phi_{ase2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

$$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.00069813$$

$$\phi_{psh,x} = \phi_{ps1,x} + \phi_{ps2,x} + \phi_{ps3,x} = 0.00356047$$

$$\phi_{ps1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

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

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

$$\phi_{ps2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

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

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

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

$$h_3 = 1800.00$$

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

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

$$\phi_{psh,y} = \phi_{ps1,y} + \phi_{ps2,y} + \phi_{ps3,y} = 0.00069813$$

$$\phi_{ps1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

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

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

$$\phi_{ps2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

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

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

$$\phi_{ps3,y} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

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

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

$$A_{sec} = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 625.00$$

$$f_{ce} = 20.00$$


```

From ((5.A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00084854
sh1 = 0.00271532
ft1 = 254.5614
fy1 = 212.1345
su1 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 212.1345
with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04026409
2 = Asl,com/(b*d)*(fs2/fc) = 0.04026409
v = Asl,mid/(b*d)*(fsv/fc) = 0.02734113
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04801038
2 = Asl,com/(b*d)*(fs2/fc) = 0.04801038
v = Asl,mid/(b*d)*(fsv/fc) = 0.03260121
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->

```

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

---->

$$su(4.9) = 0.24303049$$

$$Mu = MRc(4.14) = 1.0758E+008$$

$$u = su(4.1) = 1.7245646E-005$$

Calculation of ratio l_b/l_d

$$\text{Lap Length: } l_b/l_d = 0.14149197$$

$$l_b = 300.00$$

$$l_d = 2120.262$$

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

l_d ,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 16.85714$$

$$\text{Mean strength value of all re-bars: } f_y = 625.00$$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of Mu_{2+}

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

$$u = 1.7029732E-005$$

$$Mu = 8.8591E+007$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00220465$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

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

The Shear_factor is considered equal to 1 (pure moment strength)

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

$$w_e(5.4c) = 0.00$$

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

$$ase1 = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$ase2 = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

$$psh_{min} = \text{Min}(psh_x, psh_y) = 0.00069813$$

$$psh_x = ps1_x + ps2_x + ps3_x = 0.00356047$$

$$ps1_x(\text{column 1}) = (As1 * h1 / s_1) / A_c = 0.00083776$$

$$h1 = 600.00$$

$$As1 = Astir1 * ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2_x(\text{column 2}) = (As2 * h2 / s_2) / A_c = 0.00083776$$

$$h2 = 600.00$$

$As2 = Astir2 * ns2 = 157.0796$
 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, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y \text{ (column 1)} = (As1 * h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 * ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,y \text{ (column 2)} = (As2 * h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 * ns2 = 157.0796$
 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, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 625.00$
 $fce = 20.00$
 From ((5.A.5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y1 = 0.00084854$
 $sh1 = 0.00271532$
 $ft1 = 254.5614$
 $fy1 = 212.1345$
 $su1 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/l_d = 0.14149197$
 $su1 = 0.4 * esu1_nominal \text{ ((5.5), TBDY)} = 0.032$
 From table 5A.1, TBDY: $esu1_nominal = 0.08$,
 For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1 / 1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = fs = 212.1345$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00084854$
 $sh2 = 0.00271532$
 $ft2 = 254.5614$
 $fy2 = 212.1345$
 $su2 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/l_b,min = 0.14149197$
 $su2 = 0.4 * esu2_nominal \text{ ((5.5), TBDY)} = 0.032$
 From table 5A.1, TBDY: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2 / 1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = fs = 212.1345$
 with $Es2 = Es = 200000.00$
 $yv = 0.00084854$
 $shv = 0.00271532$
 $ftv = 254.5614$
 $fyv = 212.1345$
 $suv = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.14149197$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_{nominal}$ and yv, shv, ftv, fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fsv = fs = 212.1345$
with $Esv = Es = 200000.00$
 $1 = Asl_{ten}/(b*d) * (fs1/fc) = 0.04026409$
 $2 = Asl_{com}/(b*d) * (fs2/fc) = 0.04026409$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.00$
and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $fcc (5A.2, TBDY) = 20.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_{ten}/(b*d) * (fs1/fc) = 0.04801038$
 $2 = Asl_{com}/(b*d) * (fs2/fc) = 0.04801038$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.00$
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
 $v < vsy2$ - LHS eq.(4.5) is satisfied
--->
 $su (4.9) = 0.23343312$
 $Mu = MRc (4.14) = 8.8591E+007$
 $u = su (4.1) = 1.7029732E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$
 $l_b = 300.00$
 $l_d = 2120.262$
Calculation of l_b,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 16.85714$
Mean strength value of all re-bars: $fy = 625.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.24399$
 $n = 28.00$

Calculation of $Mu2$ -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.7245646E-005$
 $Mu = 1.0758E+008$

with full section properties:
 $b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00220465$
 $N = 27514.027$

$f_c = 20.00$
 $c_o (5A.5, TBDY) = 0.002$
 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)
 From (5.4b), TBDY: $c_u = 0.0035$
 $w_e (5.4c) = 0.00$
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$
 $a_{se1} = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $a_{se2} = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $a_{se3} = 0$ (grid does not provide confinement)
 $p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$
 $p_{s1,x} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$
 $h_1 = 600.00$
 $A_{s1} = A_{stir1} * n_{s1} = 157.0796$
 No stirups, $n_{s1} = 2.00$
 $p_{s2,x} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$
 $h_2 = 600.00$
 $A_{s2} = A_{stir2} * n_{s2} = 157.0796$
 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, $n_{s3} = 2.00$

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$
 $p_{s1,y} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$
 $h_1 = 250.00$
 $A_{s1} = A_{stir1} * n_{s1} = 157.0796$
 No stirups, $n_{s1} = 2.00$
 $p_{s2,y} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$
 $h_2 = 250.00$
 $A_{s2} = A_{stir2} * n_{s2} = 157.0796$
 No stirups, $n_{s2} = 2.00$
 $p_{s3,y} (\text{web}) = (A_{s3} * h_3 / s_3) / A_c = 0.00$
 $h_3 = 250.00$
 $A_{s3} = A_{stir3} * n_{s3} = 157.0796$
 No stirups, $n_{s3} = 0.00$

$A_{sec} = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $f_{ywe} = 625.00$
 $f_{ce} = 20.00$

From ((5.A5), TBDY), TBDY: $c_c = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y_1 = 0.00084854$
 $sh_1 = 0.00271532$
 $ft_1 = 254.5614$
 $fy_1 = 212.1345$
 $su_1 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = l_b / l_d = 0.14149197$
 $su_1 = 0.4 * esu_1_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_1_{nominal} = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = fs = 212.1345$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00084854$
 $sh2 = 0.00271532$
 $ft2 = 254.5614$
 $fy2 = 212.1345$
 $su2 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou, min = lb/lb, min = 0.14149197$
 $su2 = 0.4 \cdot esu2_nominal \cdot ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = fs = 212.1345$
 with $Es2 = Es = 200000.00$
 $yv = 0.00084854$
 $shv = 0.00271532$
 $ftv = 254.5614$
 $fyv = 212.1345$
 $suv = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou, min = lb/ld = 0.14149197$
 $suv = 0.4 \cdot esuv_nominal \cdot ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 212.1345$
 with $Esv = Es = 200000.00$
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.04026409$
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.04026409$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.02734113$

and confined core properties:

$b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 fcc (5A.2, TBDY) = 20.00
 cc (5A.5, TBDY) = 0.002
 $c =$ confinement factor = 1.00
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.04801038$
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.04801038$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.03260121$

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

--->
 $v < vs, y2$ - LHS eq.(4.5) is satisfied
 --->
 su (4.9) = 0.24303049
 $Mu = MRc$ (4.14) = 1.0758E+008
 $u = su$ (4.1) = 1.7245646E-005

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.14149197$
 $lb = 300.00$
 $ld = 2120.262$

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

ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$db = 16.85714$$

Mean strength value of all re-bars: $f_y = 625.00$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 834708.585$

Calculation of Shear Strength at edge 1, $V_{r1} = 834708.585$

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: $V_c = 729988.83$

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

= 1 (normal-weight concrete)

$$f'_c = 20.00, \text{ but } f'_c \cdot 0.5 \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$h = 3000.00$$

$$d = 200.00$$

$$l_w = 250.00$$

$$\mu_u = 3.9108324E-011$$

$$V_u = 4.7331654E-030$$

$$N_u = 27514.027$$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 104719.755$

$V_{s1} = 52359.878$ is calculated for pseudo-Column 1, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 500.00$$

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

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

$V_{s2} = 52359.878$ is calculated for pseudo-Column 2, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 500.00$$

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

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

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

$$d = 200.00$$

$$A_v = 0.00$$

$$s = 200.00$$

$$f_y = 500.00$$

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

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

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

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 1.7825E+006$$

$$b_w = 3000.00$$

Calculation of Shear Strength at edge 2, $V_{r2} = 834708.585$

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: $V_c = 729988.83$

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

= 1 (normal-weight concrete)

$f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$M_u = 3.9108324E-011$

$V_u = 4.7331654E-030$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 104719.755$

$V_{s1} = 52359.878$ is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

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

$V_{s2} = 52359.878$ is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

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

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

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 500.00$

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: $V_s + V_f \leq 1.7825E+006$

$b_w = 3000.00$

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: 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

$n = 0.00069813$

with $n = p_{s1} + p_{s2} + p_{s3}$, being the shear reinf. ratio in a plane perpendicular to the shear axis 3

(pseudo-col.1 $p_{s1} = A_{s1} \cdot b_1 / s_1 = (A_{s1} \cdot h_1 / s_1) / A_c = 0.00034907$

$h_1 = 250.00$

$s_1 = 150.00$

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

(pseudo-col.2 $p_{s2} = A_{s2} \cdot b_2 / s_2 = (A_{s2} \cdot h_2 / s_2) / A_c = 0.00034907$

$h_2 = 250.00$

$s_2 = 150.00$

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

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

$h_3 = 250.00$

$s_3 = 200.00$

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

total section area, $A_c = 750000.00$

Consequently:

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

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

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_b = 300.00$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 8.9797E+007$

Shear Force, $V_2 = 2.8553711E-014$

Shear Force, $V_3 = -30202.562$

Axial Force, $F = -30954.347$

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: $As_{ten} = 2865.133$

-Compression: $As_{com} = 2865.133$

-Middle: $As_{mid} = 615.7522$

Mean Diameter of Tension Reinforcement, $Db_L = 17.33333$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.01540528$

$u = y + p = 0.01540528$

- Calculation of y -

 $y = (M_y * I_p) / (EI)_{Eff} = 0.00040528$ ((10-5), ASCE 41-17))

$M_y = 1.7117E+009$

$(EI)_{Eff} = 0.35 * E_c * I$ (table 10-5)

$E_c * I = 1.4480E+016$

$I_p = 0.5 * d = 0.5 * (0.8 * h) = 1200.00$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

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

$y_{ten} = 4.1973704E-007$

with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b / d)^{2/3}) = 196.9282$

$d = 2957.00$

$y = 0.20667842$

$A = 0.00879703$

$B = 0.00456724$

with $pt = 0.00387573$

$pc = 0.00387573$

$pv = 0.00083294$

$N = 30954.347$

$b = 250.00$
 $" = 0.01454177$
 $y_{comp} = 2.3329189E-006$
 with $f_c = 20.00$
 $E_c = 25742.96$
 $y = 0.20271835$
 $A = 0.00843469$
 $B = 0.00435462$
 with $E_s = 200000.00$

Calculation of ratio I_b/I_d

Lap Length: $I_d/I_{d,min} = 0.17686496$

$I_b = 300.00$

$I_d = 1696.209$

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

$I_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)

$= 1$

$db = 16.85714$

Mean strength value of all re-bars: $f_y = 500.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

- Calculation of p -

Considering wall controlled by flexure (shear control ratio ≤ 1),

from table 10-19: $p = 0.015$

with:

- Condition i (shear wall and wall segments)

- $(A_s - A_s') * f_y + P) / (t_w * l_w * f_c') = -0.20947028$

$A_s = 0.00$

$A_s' = 6346.017$

$f_y = 500.00$

$P = 30954.347$

$t_w = 250.00$

$l_w = 3000.00$

$f_c = 20.00$

- $V / (t_w * l_w * f_c^{0.5}) = 0.10844031$, NOTE: units in lb & in

- Confined Boundary: No

Boundary hoops spacing exceed $8db$ ($s_1 > 8*db$ or $s_2 > 8*db$)

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

With

Boundary Element 1:

$V_{w1} = 251327.412$

$s_1 = 150.00$

Boundary Element 2:

$V_{w2} = 251327.412$

$s_2 = 150.00$

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

Concrete Shear Force, $V_c = 690681.728$

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

Mean diameter of all bars, $db = 17.33333$

Design Shear Force, $V = 30202.562$

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: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: Start

Local Axis: (3)



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

At local axis: 3

Integration Section: (a)

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, ASCE 41-17.

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

Consequently:

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

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

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = l_b = 300.00$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 8.9797E+007$

Shear Force, $V_a = -30202.562$

EDGE -B-

Bending Moment, $M_b = 828340.466$

Shear Force, $V_b = 30202.562$

BOTH EDGES

Axial Force, $F = -30954.347$

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, $Db_{L,ten} = 17.33333$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 1.7588E+006$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d = 1.7588E+006$

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: $V_c = 690681.728$

$\mu_u / V_u - l_w / 2 = 1473.165 > 0$

= 1 (normal-weight concrete)

$f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 8.9797E+007$

$V_u = 30202.562$

$N_u = 30954.347$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0681E+006$

$V_{s1} = 251327.412$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

$V_{s2} = 251327.412$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

$V_{s3} = 565486.678$ is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 500.00$

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: $V_s + V_f \leq 1.7825E+006$

$b_w = 250.00$

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: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (ϕ_r)

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: rcw

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

Consequently:

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

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

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

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 625.00$

#####

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

Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_o = 300.00$
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, $V_a = 2.0194839E-028$
EDGE -B-
Shear Force, $V_b = -2.0194839E-028$
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, $V_e/V_r = 0.68720049$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 1.2357E+006$
with
 $M_{pr1} = \max(\mu_{1+}, \mu_{1-}) = 1.8535E+009$
 $\mu_{1+} = 1.7546E+009$, 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
 $\mu_{1-} = 1.8535E+009$, 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
 $M_{pr2} = \max(\mu_{2+}, \mu_{2-}) = 1.8535E+009$
 $\mu_{2+} = 1.7546E+009$, 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
 $\mu_{2-} = 1.8535E+009$, 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 μ_{1+}

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:
 $\mu = 1.1650088E-006$
 $\mu_u = 1.7546E+009$

with full section properties:

$b = 250.00$
 $d = 2957.00$
 $d' = 43.00$
 $v = 0.00186094$
 $N = 27514.027$
 $f_c = 20.00$
 $\alpha (5A.5, \text{TB DY}) = 0.002$
Final value of α_u : $\alpha_u = \text{shear_factor} * \max(\alpha_u, \alpha_c) = 0.0035$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TB DY: $\alpha_u = 0.0035$
 $\alpha_w (5.4c) = 0.00$
 $\alpha_{se} ((5.4d), \text{TB DY}) = (\alpha_{se1} * A_{col1} + \alpha_{se2} * A_{col2} + \alpha_{se3} * A_{web}) / A_{sec} = 0.00$
 $\alpha_{se1} = 0.00$

```

sh_1 = 150.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 150.00
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) = 0.00069813

```

```

psh,x = ps1,x+ps2,x+ps3,x = 0.00356047
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00083776
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776
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 = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
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 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 625.00
fce = 20.00

```

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

```

y1 = 0.00084854
sh1 = 0.00271532
ft1 = 254.5614
fy1 = 212.1345
su1 = 0.00271532

```

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

lo/lou,min = lb/lb = 0.14149197

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

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

with fs1 = fs = 212.1345

with Es1 = Es = 200000.00

```

y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614

```

```

fy2 = 212.1345
su2 = 0.00271532
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.14149197
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = fs = 212.1345
    with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.14149197
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = fs = 212.1345
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04110878
2 = Asl,com/(b*d)*(fs2/fc) = 0.04110878
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) = 20.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.0546449
    2 = Asl,com/(b*d)*(fs2/fc) = 0.0546449
    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) = 0.21179234
Mu = MRc (4.14) = 1.7546E+009
u = su (4.1) = 1.1650088E-006

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.14149197
lb = 300.00
ld = 2120.262
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 625.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00

```


Ktr = 2.24399
n = 28.00

Calculation of Mu1-

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

$\phi_u = 1.1680845E-006$

$M_u = 1.8535E+009$

with full section properties:

b = 250.00

d = 2957.00

d' = 43.00

$\nu = 0.00186094$

N = 27514.027

$f_c = 20.00$

ϕ_{co} (5A.5, TBDY) = 0.002

Final value of ϕ_{cu} : $\phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{co}) = 0.0035$

The Shear_factor is considered equal to 1 (pure moment strength)

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

ϕ_{we} (5.4c) = 0.00

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

$\phi_{ase1} = 0.00$

$\phi_{sh_1} = 150.00$

$\phi_{bo_1} = 190.00$

$\phi_{ho_1} = 540.00$

$\phi_{bi2_1} = 655400.00$

$\phi_{ase2} = 0.00$

$\phi_{sh_2} = 150.00$

$\phi_{bo_2} = 190.00$

$\phi_{ho_2} = 540.00$

$\phi_{bi2_2} = 655400.00$

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

$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.00069813$

$\phi_{psh,x} = \phi_{ps1,x} + \phi_{ps2,x} + \phi_{ps3,x} = 0.00356047$

$\phi_{ps1,x}$ (column 1) = $(A_{s1} * h_1 / s_1) / A_c = 0.00083776$

$h_1 = 600.00$

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

No stirups, $n_{s1} = 2.00$

$\phi_{ps2,x}$ (column 2) = $(A_{s2} * h_2 / s_2) / A_c = 0.00083776$

$h_2 = 600.00$

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

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, $n_{s3} = 2.00$

$\phi_{psh,y} = \phi_{ps1,y} + \phi_{ps2,y} + \phi_{ps3,y} = 0.00069813$

$\phi_{ps1,y}$ (column 1) = $(A_{s1} * h_1 / s_1) / A_c = 0.00034907$

$h_1 = 250.00$

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

No stirups, $n_{s1} = 2.00$

$\phi_{ps2,y}$ (column 2) = $(A_{s2} * h_2 / s_2) / A_c = 0.00034907$

$h_2 = 250.00$

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

No stirups, $n_{s2} = 2.00$

$\phi_{ps3,y}$ (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, $n_{s3} = 0.00$

```

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 625.00
fce = 20.00
From ((5A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00084854
sh1 = 0.00271532
ft1 = 254.5614
fy1 = 212.1345
su1 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$ , from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$ , from 10.3.5, ASCE 41-17.
with fs2 = fs = 212.1345
with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$ , from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04110878
2 = Asl,com/(b*d)*(fs2/fc) = 0.04110878
v = Asl,mid/(b*d)*(fsv/fc) = 0.00883478
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00

```

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.0546449$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.0546449$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.01174386$$

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

--->

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

--->

$$s_u(4.9) = 0.21386777$$

$$M_u = M_{Rc}(4.14) = 1.8535E+009$$

$$u = s_u(4.1) = 1.1680845E-006$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$

$$l_b = 300.00$$

$$l_d = 2120.262$$

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

l_d ,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 16.85714$$

Mean strength value of all re-bars: $f_y = 625.00$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of M_{u2+}

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

$$u = 1.1650088E-006$$

$$M_u = 1.7546E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00186094$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

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

The Shear_factor is considered equal to 1 (pure moment strength)

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

$$w_e(5.4c) = 0.00$$

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

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

$$psh,min = \text{Min}(psh,x, psh,y) = 0.00069813$$

$$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$$

$ps1,x$ (column 1) = $(As1 \cdot h1 / s_1) / A_c = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,x$ (column 2) = $(As2 \cdot h2 / s_2) / A_c = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 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, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y$ (column 1) = $(As1 \cdot h1 / s_1) / A_c = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,y$ (column 2) = $(As2 \cdot h2 / s_2) / A_c = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 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, $ns3 = 0.00$

$A_{sec} = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$

$fy_{we} = 625.00$
 $f_{ce} = 20.00$

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

$y1 = 0.00084854$
 $sh1 = 0.00271532$

$ft1 = 254.5614$
 $fy1 = 212.1345$

$su1 = 0.00271532$

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

$lo/lo_{u,min} = lb/ld = 0.14149197$

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

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

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

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

with $fs1 = fs = 212.1345$

with $Es1 = Es = 200000.00$

$y2 = 0.00084854$
 $sh2 = 0.00271532$

$ft2 = 254.5614$
 $fy2 = 212.1345$

$su2 = 0.00271532$

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

$lo/lo_{u,min} = lb/lb_{min} = 0.14149197$

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

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

For calculation of $esu2_{nominal}$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

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

with $fs2 = fs = 212.1345$

with $Es2 = Es = 200000.00$

```

yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04110878
2 = Asl,com/(b*d)*(fs2/fc) = 0.04110878
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) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0546449
2 = Asl,com/(b*d)*(fs2/fc) = 0.0546449
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) = 0.21179234
Mu = MRc (4.14) = 1.7546E+009
u = su (4.1) = 1.1650088E-006
-----

Calculation of ratio lb/ld
-----

Lap Length: lb/ld = 0.14149197
lb = 300.00
ld = 2120.262
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 625.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00
-----

Calculation of Mu2-
-----

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.1680845E-006
Mu = 1.8535E+009
-----

```

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00186094$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

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

The Shear_factor is considered equal to 1 (pure moment strength)

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

$$w_e(5.4c) = 0.00$$

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

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$$

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$$

$$p_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

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

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

$$p_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

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

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

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

$$h_3 = 1800.00$$

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

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

$$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$$

$$p_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

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

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

$$p_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

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

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

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

$$h_3 = 250.00$$

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

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

$$A_{sec} = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 625.00$$

$$f_{ce} = 20.00$$

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

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

$$y_1 = 0.00084854$$

$$sh_1 = 0.00271532$$

$$ft_1 = 254.5614$$

$$fy_1 = 212.1345$$

$$su_1 = 0.00271532$$

```

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 212.1345
with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04110878
2 = Asl,com/(b*d)*(fs2/fc) = 0.04110878
v = Asl,mid/(b*d)*(fsv/fc) = 0.00883478
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0546449
2 = Asl,com/(b*d)*(fs2/fc) = 0.0546449
v = Asl,mid/(b*d)*(fsv/fc) = 0.01174386
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.21386777
Mu = MRc (4.14) = 1.8535E+009
u = su (4.1) = 1.1680845E-006

```

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$

$l_b = 300.00$

$l_d = 2120.262$

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

l_d ,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$= 1$

$db = 16.85714$

Mean strength value of all re-bars: $f_y = 625.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 1.7981\text{E}+006$

Calculation of Shear Strength at edge 1, $V_{r1} = 1.7981\text{E}+006$

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: $V_c = 729988.83$

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

$= 1$ (normal-weight concrete)

$f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 1.6689249\text{E}-009$

$V_u = 2.0194839\text{E}-028$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0681\text{E}+006$

$V_{s1} = 251327.412$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

$V_{s2} = 251327.412$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

$V_{s3} = 565486.678$ is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 500.00$

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: $V_s + V_f \leq 1.7825\text{E}+006$

$bw = 250.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 1.7981\text{E}+006$

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: $V_c = 729988.83$
 $M_u/V_u - l_w/2 = 0.00 \leq 0$
 $= 1$ (normal-weight concrete)
 $f'_c = 20.00$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 250.00$
 $d = 2400.00$
 $l_w = 3000.00$
 $M_u = 1.6689249E-009$
 $V_u = 2.0194839E-028$
 $N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0681E+006$
 $V_{s1} = 251327.412$ is calculated for pseudo-Column 1, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 500.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 251327.412$ is calculated for pseudo-Column 2, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 500.00$
 V_{s2} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s3} = 565486.678$ is calculated for web, with:
 $d = 1440.00$
 $A_v = 157079.633$
 $s = 200.00$
 $f_y = 500.00$
 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: $V_s + V_f \leq 1.7825E+006$
 $b_w = 250.00$

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: rcrrws

Constant Properties

Knowledge Factor, $= 1.00$
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 20.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 500.00$
Concrete Elasticity, $E_c = 25742.96$
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
New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 625.00$

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
Smooth Bars

Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_o = 300.00$
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = -4.7331654E-030$
EDGE -B-
Shear Force, $V_b = 4.7331654E-030$
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: $As_{t,ten} = 2368.761$
-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 , $V_e/V_r = 0.08592175$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 71719.625$
with
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 1.0758E+008$
 $Mu_{1+} = 8.8591E+007$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
 $Mu_{1-} = 1.0758E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 1.0758E+008$
 $Mu_{2+} = 8.8591E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
 $Mu_{2-} = 1.0758E+008$, 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_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 1.7029732E-005$
 $Mu = 8.8591E+007$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00220465$
 $N = 27514.027$
 $f_c = 20.00$
 $co (5A.5, TBDY) = 0.002$
Final value of ϕ_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: $\phi_u = 0.0035$
 $\phi_{se} (5.4c) = 0.00$
 $\phi_{se} ((5.4d), TBDY) = (\phi_{se1} * A_{col1} + \phi_{se2} * A_{col2} + \phi_{se3} * A_{web}) / A_{sec} = 0.00$
 $\phi_{se1} = 0.00$
 $\phi_{sh_1} = 150.00$

```

bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 150.00
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) = 0.00069813

```

```

psh,x = ps1,x+ps2,x+ps3,x = 0.00356047
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00083776
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776
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 = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
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 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 625.00
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00084854
sh1 = 0.00271532
ft1 = 254.5614
fy1 = 212.1345
su1 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345

```

```

su2 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 212.1345
with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04026409
2 = Asl,com/(b*d)*(fs2/fc) = 0.04026409
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) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04801038
2 = Asl,com/(b*d)*(fs2/fc) = 0.04801038
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) = 0.23343312
Mu = MRc (4.14) = 8.8591E+007
u = su (4.1) = 1.7029732E-005

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.14149197
lb = 300.00
ld = 2120.262
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 625.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399

```

n = 28.00

Calculation of Mu1-

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

$\phi_u = 1.7245646E-005$

$M_u = 1.0758E+008$

with full section properties:

b = 3000.00

d = 208.00

d' = 42.00

$\nu = 0.00220465$

N = 27514.027

$f_c = 20.00$

ϕ_{co} (5A.5, TBDY) = 0.002

Final value of ϕ_{cu} : $\phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{co}) = 0.0035$

The Shear_factor is considered equal to 1 (pure moment strength)

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

ϕ_{we} (5.4c) = 0.00

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

$\phi_{ase1} = 0.00$

$\phi_{sh_1} = 150.00$

$\phi_{bo_1} = 190.00$

$\phi_{ho_1} = 540.00$

$\phi_{bi2_1} = 655400.00$

$\phi_{ase2} = 0.00$

$\phi_{sh_2} = 150.00$

$\phi_{bo_2} = 190.00$

$\phi_{ho_2} = 540.00$

$\phi_{bi2_2} = 655400.00$

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

$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.00069813$

$\phi_{psh,x} = \phi_{ps1,x} + \phi_{ps2,x} + \phi_{ps3,x} = 0.00356047$

$\phi_{ps1,x}$ (column 1) = $(A_{s1} * h_1 / s_1) / A_c = 0.00083776$

$h_1 = 600.00$

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

No stirups, $n_{s1} = 2.00$

$\phi_{ps2,x}$ (column 2) = $(A_{s2} * h_2 / s_2) / A_c = 0.00083776$

$h_2 = 600.00$

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

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, $n_{s3} = 2.00$

$\phi_{psh,y} = \phi_{ps1,y} + \phi_{ps2,y} + \phi_{ps3,y} = 0.00069813$

$\phi_{ps1,y}$ (column 1) = $(A_{s1} * h_1 / s_1) / A_c = 0.00034907$

$h_1 = 250.00$

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

No stirups, $n_{s1} = 2.00$

$\phi_{ps2,y}$ (column 2) = $(A_{s2} * h_2 / s_2) / A_c = 0.00034907$

$h_2 = 250.00$

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

No stirups, $n_{s2} = 2.00$

$\phi_{ps3,y}$ (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 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 625.00
fce = 20.00
From ((5.A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00084854
sh1 = 0.00271532
ft1 = 254.5614
fy1 = 212.1345
su1 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 212.1345
with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04026409
2 = Asl,com/(b*d)*(fs2/fc) = 0.04026409
v = Asl,mid/(b*d)*(fsv/fc) = 0.02734113
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04801038

```

$$2 = A_{sl,com}/(b*d)*(f_s2/f_c) = 0.04801038$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.03260121$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

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

---->

$$s_u(4.9) = 0.24303049$$

$$M_u = M_{Rc}(4.14) = 1.0758E+008$$

$$u = s_u(4.1) = 1.7245646E-005$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$

$$l_b = 300.00$$

$$l_d = 2120.262$$

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

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 16.85714$$

Mean strength value of all re-bars: $f_y = 625.00$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of M_{u2+}

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

$$u = 1.7029732E-005$$

$$M_u = 8.8591E+007$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00220465$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

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

The Shear_factor is considered equal to 1 (pure moment strength)

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

$$w_e(5.4c) = 0.00$$

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

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$$

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$$

$$p_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$h1 = 600.00$
 $As1 = Astir1 * ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,x \text{ (column 2)} = (As2 * h2 / s_2) / Ac = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 * ns2 = 157.0796$
 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, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y \text{ (column 1)} = (As1 * h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 * ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,y \text{ (column 2)} = (As2 * h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 * ns2 = 157.0796$
 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, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$

$fywe = 625.00$
 $fce = 20.00$

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

$y1 = 0.00084854$
 $sh1 = 0.00271532$
 $ft1 = 254.5614$
 $fy1 = 212.1345$
 $su1 = 0.00271532$

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

$lo/lou,min = lb/ld = 0.14149197$

$su1 = 0.4 * esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1 / 1.2$, from table 5.1, TBDY.

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

with $fs1 = fs = 212.1345$

with $Es1 = Es = 200000.00$

$y2 = 0.00084854$
 $sh2 = 0.00271532$
 $ft2 = 254.5614$
 $fy2 = 212.1345$
 $su2 = 0.00271532$

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

$lo/lou,min = lb/lb,min = 0.14149197$

$su2 = 0.4 * esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2 / 1.2$, from table 5.1, TBDY.

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

with $fs2 = fs = 212.1345$

with $Es2 = Es = 200000.00$

$yv = 0.00084854$


```

shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04026409
2 = Asl,com/(b*d)*(fs2/fc) = 0.04026409
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) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04801038
2 = Asl,com/(b*d)*(fs2/fc) = 0.04801038
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) = 0.23343312
Mu = MRc (4.14) = 8.8591E+007
u = su (4.1) = 1.7029732E-005

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.14149197
lb = 300.00
ld = 2120.262

```

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

```

= 1
db = 16.85714
Mean strength value of all re-bars: fy = 625.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

```

Calculation of Mu2-

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

```

u = 1.7245646E-005
Mu = 1.0758E+008

```

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00220465$
 $N = 27514.027$
 $f_c = 20.00$
 $\phi (5A.5, TBDY) = 0.002$
 Final value of ϕ : $\phi^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\phi_u = 0.0035$
 $\phi_w (5.4c) = 0.00$
 $\phi_{se} ((5.4d), TBDY) = (\phi_{se1} * A_{col1} + \phi_{se2} * A_{col2} + \phi_{se3} * A_{web}) / A_{sec} = 0.00$
 $\phi_{se1} = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $\phi_{se2} = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $\phi_{se3} = 0$ (grid does not provide confinement)
 $\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00069813$

$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00356047$
 $\phi_{s1,x} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$
 $h_1 = 600.00$
 $A_{s1} = A_{stir1} * n_{s1} = 157.0796$
 No stirups, $n_{s1} = 2.00$
 $\phi_{s2,x} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$
 $h_2 = 600.00$
 $A_{s2} = A_{stir2} * n_{s2} = 157.0796$
 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, $n_{s3} = 2.00$

$\phi_{sh,y} = \phi_{s1,y} + \phi_{s2,y} + \phi_{s3,y} = 0.00069813$
 $\phi_{s1,y} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$
 $h_1 = 250.00$
 $A_{s1} = A_{stir1} * n_{s1} = 157.0796$
 No stirups, $n_{s1} = 2.00$
 $\phi_{s2,y} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$
 $h_2 = 250.00$
 $A_{s2} = A_{stir2} * n_{s2} = 157.0796$
 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, $n_{s3} = 0.00$

$A_{sec} = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $f_{ywe} = 625.00$
 $f_{ce} = 20.00$
 From ((5A5), TBDY), TBDY: $\phi_c = 0.002$
 $\phi_c = \text{confinement factor} = 1.00$
 $y_1 = 0.00084854$
 $sh_1 = 0.00271532$
 $ft_1 = 254.5614$
 $fy_1 = 212.1345$
 $su_1 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.14149197$
 $su_1 = 0.4 * esu_{1,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{1,nominal} = 0.08$,
 For calculation of $esu_{1,nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = fs = 212.1345$
 with $Es_1 = Es = 200000.00$
 $y_2 = 0.00084854$
 $sh_2 = 0.00271532$
 $ft_2 = 254.5614$
 $fy_2 = 212.1345$
 $su_2 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.14149197$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 212.1345$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00084854$
 $sh_v = 0.00271532$
 $ft_v = 254.5614$
 $fy_v = 212.1345$
 $suv = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.14149197$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 212.1345$
 with $Esv = Es = 200000.00$
 $1 = Asl_{ten}/(b * d) * (fs_1/fc) = 0.04026409$
 $2 = Asl_{com}/(b * d) * (fs_2/fc) = 0.04026409$
 $v = Asl_{mid}/(b * d) * (fsv/fc) = 0.02734113$
 and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 20.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_{ten}/(b * d) * (fs_1/fc) = 0.04801038$
 $2 = Asl_{com}/(b * d) * (fs_2/fc) = 0.04801038$
 $v = Asl_{mid}/(b * d) * (fsv/fc) = 0.03260121$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.24303049$
 $Mu = MRc (4.14) = 1.0758E+008$
 $u = su (4.1) = 1.7245646E-005$

 Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$

$l_b = 300.00$

$l_d = 2120.262$

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

l_d , min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$= 1$

$db = 16.85714$

Mean strength value of all re-bars: $f_y = 625.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 834708.585$

Calculation of Shear Strength at edge 1, $V_{r1} = 834708.585$

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: $V_c = 729988.83$

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

$= 1$ (normal-weight concrete)

$f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$\mu_u = 3.9108324E-011$

$V_u = 4.7331654E-030$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 104719.755$

$V_{s1} = 52359.878$ is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

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

$V_{s2} = 52359.878$ is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

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

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

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 500.00$

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: $V_s + V_f \leq 1.7825E+006$

$b_w = 3000.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 834708.585$

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: $V_c = 729988.83$

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

= 1 (normal-weight concrete)

$f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$M_u = 3.9108324E-011$

$V_u = 4.7331654E-030$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 104719.755$

$V_{s1} = 52359.878$ is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

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

$V_{s2} = 52359.878$ is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

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

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

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 500.00$

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: $V_s + V_f \leq 1.7825E+006$

$b_w = 3000.00$

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, = 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

$n = 0.00069813$

with $n = p_{s1} + p_{s2} + p_{s3}$, being the shear reinf. ratio in a plane perpendicular to the shear axis 2

(pseudo-col.1 $p_{s1} = A_{s1} \cdot b_1 / s_1 = (A_{s1} \cdot h_1 / s_1) / A_c = 0.00034907$

$h_1 = 250.00$

$s_1 = 150.00$

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

(pseudo-col.2 $p_{s2} = A_{s2} \cdot b_2 / s_2 = (A_{s2} \cdot h_2 / s_2) / A_c = 0.00034907$

$h_2 = 250.00$

$s_2 = 150.00$

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

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

$$h_3 = 250.00$$

$$s_3 = 200.00$$

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

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

Consequently:

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

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

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_b = 300.00$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 6.2281024E-010$

Shear Force, $V_2 = 2.8553711E-014$

Shear Force, $V_3 = -30202.562$

Axial Force, $F = -30954.347$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{slt} = 0.00$

-Compression: $A_{slc} = 6346.017$

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, $D_bL = 17.20$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.01576811$

$$u = y + p = 0.01576811$$

- Calculation of y -

$$y = (M_y * I_p) / (E I)_{Eff} = 0.00076811 \text{ ((10-5), ASCE 41-17)}$$

$$M_y = 1.1264E+008$$

$$(E I)_{Eff} = 0.35 * E_c * I \text{ (table 10-5)}$$

$$E_c * I = 1.0056E+014$$

$$I_p = 0.5 * d = 0.5 * (0.8 * h) = 240.00$$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

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

$$y_{ten} = 6.2595522E-006$$

$$\text{with ((10.1), ASCE 41-17)} f_y = \text{Min}(f_y, 1.25 * f_y * (l_b / l_d)^{2/3}) = 196.9282$$

$$d = 208.00$$

$$y = 0.24373973$$

$$A = 0.0104218$$

```

B = 0.00636362
with pt = 0.00379609
pc = 0.00379609
pv = 0.00257772
N = 30954.347
b = 3000.00
" = 0.20192308
y_comp = 2.7995026E-005
with fc = 20.00
Ec = 25742.96
y = 0.24015952
A = 0.00999254
B = 0.00611172
with Es = 200000.00

```

Calculation of ratio l_b/l_d

```

Lap Length:  $l_d/l_{d,min}$  = 0.17686496
l_b = 300.00
l_d = 1696.209

```

Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)

```

= 1
db = 16.85714
Mean strength value of all re-bars:  $f_y$  = 500.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

```

- Calculation of p -

Considering wall controlled by flexure (shear control ratio ≤ 1),
from table 10-19: $p = 0.015$
with:

- Condition i (shear wall and wall segments)

- $(A_s - A_s') * f_y + P) / (t_w * l_w * f_c') = -0.20947028$

```

As = 0.00
As' = 6346.017
fy = 500.00
P = 30954.347
tw = 3000.00
lw = 250.00
fc = 20.00

```

- $V / (t_w * l_w * f_c'^{0.5}) = 1.0252022E-019$, NOTE: units in lb & in

- Confined Boundary: No

Boundary hoops spacing exceed $8d_b$ ($s_1 > 8 * d_b$ or $s_2 > 8 * d_b$)

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

With

Boundary Element 1:

```

Vw1 = 104719.755
s1 = 150.00

```

Boundary Element 2:

```

Vw2 = 104719.755
s2 = 150.00

```

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

Concrete Shear Force, $V_c = 137314.38$

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

Mean diameter of all bars, $d_b = 17.33333$

Design Shear Force, $V = 2.8553711E-014$

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

Calculation No. 13

wall W1, Floor 1
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)
Analysis: Uniform +X
Check: Shear capacity VRd
Edge: End
Local Axis: (2)



Start Of Calculation of Shear Capacity for element: wall W1 of floor 1
At local axis: 2
Integration Section: (d)
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, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$
New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$
Concrete Elasticity, $E_c = 25742.96$
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

Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_o = l_b = 300.00$
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, $M_a = 6.2281024E-010$
Shear Force, $V_a = 2.8553711E-014$
EDGE -B-
Bending Moment, $M_b = -5.2916137E-010$
Shear Force, $V_b = -2.8553711E-014$
BOTH EDGES
Axial Force, $F = -30954.347$
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, $Db_{L,ten} = 17.20$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 242595.449$
From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c' \cdot h \cdot d = 242595.449$

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: $V_c = 137875.693$
 $M_u/V_u - l_w/2 = 18407.14 > 0$
= 1 (normal-weight concrete)
 $f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 3000.00$
 $d = 200.00$
 $l_w = 250.00$
 $M_u = 5.2916137E-010$
 $V_u = 2.8553711E-014$
 $N_u = 30954.347$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 104719.755$

$V_{s1} = 52359.878$ is calculated for pseudo-Column 1, with:

$d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 500.00$

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

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

$V_{s2} = 52359.878$ is calculated for pseudo-Column 2, with:

$d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 500.00$

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

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

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

$d = 200.00$
 $A_v = 0.00$
 $s = 200.00$
 $f_y = 500.00$

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: $V_s + V_f \leq 1.7825E+006$
 $b_w = 3000.00$

End Of Calculation of Shear Capacity for element: wall W1 of floor 1
 At local axis: 2
 Integration Section: (d)

Calculation No. 14

wall W1, Floor 1
 Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)
 Analysis: Uniform +X
 Check: Chord rotation capacity (μ)
 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, $= 1.00$
 Mean strength values are used for both shear and moment calculations.
 Consequently:
 New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 20.00$
 New material of Primary Member: Steel Strength, $f_s = f_{sm} = 500.00$
 Concrete Elasticity, $E_c = 25742.96$
 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
 New material: Steel Strength, $f_s = 1.25 * f_{sm} = 625.00$
 #####

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
 Smooth Bars
 Ductile Steel
 With Detailing for Earthquake Resistance (including stirrups closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $l_o = 300.00$
 No FRP Wrapping

Stepwise Properties

At local axis: 3
 EDGE -A-
 Shear Force, $V_a = 2.0194839E-028$
 EDGE -B-
 Shear Force, $V_b = -2.0194839E-028$
 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, $V_e/V_r = 0.68720049$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 1.2357E+006$
 with
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 1.8535E+009$
 $Mu_{1+} = 1.7546E+009$, 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
 $Mu_{1-} = 1.8535E+009$, 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
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 1.8535E+009$
 $Mu_{2+} = 1.7546E+009$, 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
 $Mu_{2-} = 1.8535E+009$, 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_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 1.1650088E-006$
 $M_u = 1.7546E+009$

with full section properties:

$b = 250.00$
 $d = 2957.00$
 $d' = 43.00$
 $v = 0.00186094$
 $N = 27514.027$

$f_c = 20.00$
 $c_o (5A.5, TBDY) = 0.002$
 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)
 From (5.4b), TBDY: $c_u = 0.0035$
 $w_e (5.4c) = 0.00$
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$
 $a_{se1} = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $a_{se2} = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $a_{se3} = 0$ (grid does not provide confinement)
 $psh, \min = \text{Min}(psh, x, psh, y) = 0.00069813$

$psh, x = ps1, x + ps2, x + ps3, x = 0.00356047$
 $ps1, x$ (column 1) = $(As1 * h1 / s_1) / Ac = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 * ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2, x$ (column 2) = $(As2 * h2 / s_2) / Ac = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 * ns2 = 157.0796$
 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, $ns3 = 2.00$

$psh, y = ps1, y + ps2, y + ps3, y = 0.00069813$
 $ps1, y$ (column 1) = $(As1 * h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 * ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2, y$ (column 2) = $(As2 * h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 * ns2 = 157.0796$
 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, $ns3 = 0.00$

$A_{sec} = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fy_{we} = 625.00$
 $f_{ce} = 20.00$

From ((5.A5), TBDY), TBDY: $c_c = 0.002$
 c = confinement factor = 1.00
 $y1 = 0.00084854$
 $sh1 = 0.00271532$
 $ft1 = 254.5614$
 $fy1 = 212.1345$
 $su1 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou, \min = lb/d = 0.14149197$
 $su1 = 0.4 * esu1_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = fs = 212.1345$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00084854$
 $sh2 = 0.00271532$
 $ft2 = 254.5614$
 $fy2 = 212.1345$
 $su2 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou, min = lb/lb, min = 0.14149197$
 $su2 = 0.4 \cdot esu2_nominal \cdot ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = fs = 212.1345$
 with $Es2 = Es = 200000.00$
 $yv = 0.00084854$
 $shv = 0.00271532$
 $ftv = 254.5614$
 $fyv = 212.1345$
 $suv = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou, min = lb/ld = 0.14149197$
 $suv = 0.4 \cdot esuv_nominal \cdot ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 212.1345$
 with $Esv = Es = 200000.00$
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.04110878$
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.04110878$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00$

and confined core properties:

$b = 190.00$
 $d = 2927.00$
 $d' = 13.00$
 fcc (5A.2, TBDY) = 20.00
 cc (5A.5, TBDY) = 0.002
 c = confinement factor = 1.00
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.0546449$
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.0546449$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00$

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

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

--->
 su (4.9) = 0.21179234
 $Mu = MRc$ (4.14) = 1.7546E+009
 $u = su$ (4.1) = 1.1650088E-006

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.14149197$
 $lb = 300.00$
 $ld = 2120.262$

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

Id,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$db = 16.85714$$

Mean strength value of all re-bars: $f_y = 625.00$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of μ_1 -

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

$$u = 1.1680845E-006$$

$$\mu = 1.8535E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00186094$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

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

The Shear_factor is considered equal to 1 (pure moment strength)

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

$$we(5.4c) = 0.00$$

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

$$ase1 = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$ase2 = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

$$psh_{min} = \text{Min}(psh_x, psh_y) = 0.00069813$$

$$psh_x = ps1_x + ps2_x + ps3_x = 0.00356047$$

$$ps1_x \text{ (column 1)} = (As1 * h1 / s_1) / A_c = 0.00083776$$

$$h1 = 600.00$$

$$As1 = Astir1 * ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2_x \text{ (column 2)} = (As2 * h2 / s_2) / A_c = 0.00083776$$

$$h2 = 600.00$$

$$As2 = Astir2 * ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3_x \text{ (web)} = (As3 * h3 / s_3) / A_c = 0.00188496$$

$$h3 = 1800.00$$

$$As3 = Astir3 * ns3 = 0.00$$

$$\text{No stirups, } ns3 = 2.00$$

$$psh_y = ps1_y + ps2_y + ps3_y = 0.00069813$$

$$ps1_y \text{ (column 1)} = (As1 * h1 / s_1) / A_c = 0.00034907$$

$$h1 = 250.00$$

$$As1 = Astir1 * ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2_y \text{ (column 2)} = (As2 * h2 / s_2) / A_c = 0.00034907$$

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

$A_{sec} = 750000.00$

$s_1 = 150.00$

$s_2 = 150.00$

$s_3 = 200.00$

$fy_{we} = 625.00$

$f_{ce} = 20.00$

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

$c =$ confinement factor $= 1.00$

$y1 = 0.00084854$

$sh1 = 0.00271532$

$ft1 = 254.5614$

$fy1 = 212.1345$

$su1 = 0.00271532$

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

$lo/lou,min = lb/ld = 0.14149197$

$su1 = 0.4 * esu1_nominal ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1$, $sh1$, $ft1$, $fy1$, it is considered
characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

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

with $fs1 = fs = 212.1345$

with $Es1 = Es = 200000.00$

$y2 = 0.00084854$

$sh2 = 0.00271532$

$ft2 = 254.5614$

$fy2 = 212.1345$

$su2 = 0.00271532$

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

$lo/lou,min = lb/lb,min = 0.14149197$

$su2 = 0.4 * esu2_nominal ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2$, $sh2$, $ft2$, $fy2$, it is considered
characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

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

with $fs2 = fs = 212.1345$

with $Es2 = Es = 200000.00$

$yv = 0.00084854$

$shv = 0.00271532$

$ftv = 254.5614$

$fyv = 212.1345$

$suv = 0.00271532$

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

$lo/lou,min = lb/ld = 0.14149197$

$suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esuv_nominal = 0.08$,

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

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

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

with $fsv = fs = 212.1345$

with $Esv = Es = 200000.00$

$1 = Asl,ten / (b * d) * (fs1 / fc) = 0.04110878$

$2 = Asl,com / (b * d) * (fs2 / fc) = 0.04110878$

```

v = Asl,mid/(b*d)*(fsv/fc) = 0.00883478
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0546449
2 = Asl,com/(b*d)*(fs2/fc) = 0.0546449
v = Asl,mid/(b*d)*(fsv/fc) = 0.01174386
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.21386777
Mu = MRc (4.14) = 1.8535E+009
u = su (4.1) = 1.1680845E-006

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.14149197
lb = 300.00
ld = 2120.262
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 625.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

```

Calculation of Mu2+

```

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.1650088E-006
Mu = 1.7546E+009

```

with full section properties:

```

b = 250.00
d = 2957.00
d' = 43.00
v = 0.00186094
N = 27514.027
fc = 20.00
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 = 150.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00

```



```

sh_2 = 150.00
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) = 0.00069813

```

```

-----
psh,x = ps1,x+ps2,x+ps3,x = 0.00356047
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00083776
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776
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 = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
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 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 625.00
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00084854
sh1 = 0.00271532
ft1 = 254.5614
fy1 = 212.1345
su1 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

```

$l_o/l_{o,min} = l_b/l_{b,min} = 0.14149197$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 212.1345$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00084854$
 $sh_v = 0.00271532$
 $ft_v = 254.5614$
 $fy_v = 212.1345$
 $suv = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 0.14149197$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = fs = 212.1345$
 with $Es_v = Es = 200000.00$
 $1 = A_{sl,ten}/(b*d)*(fs_1/f_c) = 0.04110878$
 $2 = A_{sl,com}/(b*d)*(fs_2/f_c) = 0.04110878$
 $v = A_{sl,mid}/(b*d)*(fs_v/f_c) = 0.00$

and confined core properties:

$b = 190.00$
 $d = 2927.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 20.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d)*(fs_1/f_c) = 0.0546449$
 $2 = A_{sl,com}/(b*d)*(fs_2/f_c) = 0.0546449$
 $v = A_{sl,mid}/(b*d)*(fs_v/f_c) = 0.00$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su (4.9) = 0.21179234$

$\mu_u = MR_c (4.14) = 1.7546E+009$

$u = su (4.1) = 1.1650088E-006$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$

$l_b = 300.00$

$l_d = 2120.262$

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

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$db = 16.85714$

Mean strength value of all re-bars: $fy = 625.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of Mu2-

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

$$\phi_u = 1.1680845E-006$$

$$M_u = 1.8535E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00186094$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{co}) = 0.0035$$

The Shear_factor is considered equal to 1 (pure moment strength)

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

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

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

$$\phi_{ase1} = 0.00$$

$$h_{sh,1} = 150.00$$

$$b_{o,1} = 190.00$$

$$h_{o,1} = 540.00$$

$$b_{i2,1} = 655400.00$$

$$\phi_{ase2} = 0.00$$

$$h_{sh,2} = 150.00$$

$$b_{o,2} = 190.00$$

$$h_{o,2} = 540.00$$

$$b_{i2,2} = 655400.00$$

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

$$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.00069813$$

$$\phi_{psh,x} = \phi_{ps1,x} + \phi_{ps2,x} + \phi_{ps3,x} = 0.00356047$$

$$\phi_{ps1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

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

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

$$\phi_{ps2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

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

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

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

$$h_3 = 1800.00$$

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

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

$$\phi_{psh,y} = \phi_{ps1,y} + \phi_{ps2,y} + \phi_{ps3,y} = 0.00069813$$

$$\phi_{ps1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

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

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

$$\phi_{ps2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

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

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

$$\phi_{ps3,y} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

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

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

$$A_{sec} = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 625.00$$

```

fce = 20.00
From ((5A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00084854
sh1 = 0.00271532
ft1 = 254.5614
fy1 = 212.1345
su1 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 212.1345
with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04110878
2 = Asl,com/(b*d)*(fs2/fc) = 0.04110878
v = Asl,mid/(b*d)*(fsv/fc) = 0.00883478
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0546449
2 = Asl,com/(b*d)*(fs2/fc) = 0.0546449
v = Asl,mid/(b*d)*(fsv/fc) = 0.01174386
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

```

--->

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

--->

$\mu_u (4.9) = 0.21386777$

$\mu_u = M_{Rc} (4.14) = 1.8535E+009$

$u = \mu_u (4.1) = 1.1680845E-006$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$

$l_b = 300.00$

$l_d = 2120.262$

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

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$= 1$

$d_b = 16.85714$

Mean strength value of all re-bars: $f_y = 625.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 1.7981E+006$

Calculation of Shear Strength at edge 1, $V_{r1} = 1.7981E+006$

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: $V_c = 729988.83$

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

$= 1$ (normal-weight concrete)

$f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 1.6689249E-009$

$V_u = 2.0194839E-028$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0681E+006$

$V_{s1} = 251327.412$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

$V_{s2} = 251327.412$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

$V_{s3} = 565486.678$ is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 500.00$

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: $V_s + V_f \leq 1.7825E+006$

bw = 250.00

Calculation of Shear Strength at edge 2, $V_{r2} = 1.7981E+006$
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: $V_c = 729988.83$

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

= 1 (normal-weight concrete)

$f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 1.6689249E-009$

$V_u = 2.0194839E-028$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0681E+006$

$V_{s1} = 251327.412$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

$V_{s2} = 251327.412$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 500.00$

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

$V_{s3} = 565486.678$ is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 500.00$

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: $V_s + V_f \leq 1.7825E+006$

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:

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

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

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

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 625.00$

#####

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
 Smooth Bars
 Ductile Steel
 With Detailing for Earthquake Resistance (including stirrups closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $l_o = 300.00$
 No FRP Wrapping

Stepwise Properties

At local axis: 2
 EDGE -A-
 Shear Force, $V_a = -4.7331654E-030$
 EDGE -B-
 Shear Force, $V_b = 4.7331654E-030$
 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: $As_{t,ten} = 2368.761$
 -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, $V_e/V_r = 0.08592175$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 71719.625$
 with
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 1.0758E+008$
 $Mu_{1+} = 8.8591E+007$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
 $Mu_{1-} = 1.0758E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 1.0758E+008$
 $Mu_{2+} = 8.8591E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
 $Mu_{2-} = 1.0758E+008$, 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_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 1.7029732E-005$
 $Mu = 8.8591E+007$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00220465$
 $N = 27514.027$
 $f_c = 20.00$

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) = $(ase1 * Acol1 + ase2 * Acol2 + ase3 * Aweb) / Asec = 0.00$
 $ase1 = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $ase2 = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $ase3 = 0$ (grid does not provide confinement)
 $psh,min = Min(psh,x, psh,y) = 0.00069813$

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x$ (column 1) = $(As1 * h1 / s_1) / Ac = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 * ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,x$ (column 2) = $(As2 * h2 / s_2) / Ac = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 * ns2 = 157.0796$
 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, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y$ (column 1) = $(As1 * h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 * ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,y$ (column 2) = $(As2 * h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 * ns2 = 157.0796$
 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, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 625.00$
 $fce = 20.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c =$ confinement factor = 1.00
 $y1 = 0.00084854$
 $sh1 = 0.00271532$
 $ft1 = 254.5614$
 $fy1 = 212.1345$
 $su1 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lo,min = lb/d = 0.14149197$
 $su1 = 0.4 * esu1_nominal$ ((5.5), TBDY) = 0.032
 From table 5A.1, TBDY: $esu1_nominal = 0.08$,
 For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered

characteristic value $f_{sy1} = f_{s1}/1.2$, 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, ASCE 41-17.
 with $f_{s1} = f_s = 212.1345$
 with $E_{s1} = E_s = 200000.00$
 $y2 = 0.00084854$
 $sh2 = 0.00271532$
 $ft2 = 254.5614$
 $fy2 = 212.1345$
 $su2 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_{b,min} = 0.14149197$
 $su2 = 0.4 \cdot esu2_nominal \cdot ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $f_{sy2} = f_{s2}/1.2$, 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, ASCE 41-17.
 with $f_{s2} = f_s = 212.1345$
 with $E_{s2} = E_s = 200000.00$
 $yv = 0.00084854$
 $shv = 0.00271532$
 $ftv = 254.5614$
 $fyv = 212.1345$
 $suv = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 0.14149197$
 $suv = 0.4 \cdot esuv_nominal \cdot ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and 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, ASCE 41-17.
 with $f_{sv} = f_s = 212.1345$
 with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.04026409$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.04026409$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$

and confined core properties:

$b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} \text{ (5A.2, TBDY)} = 20.00$
 $cc \text{ (5A.5, TBDY)} = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.04801038$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.04801038$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$

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

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

--->
 $su \text{ (4.9)} = 0.23343312$
 $Mu = MR_c \text{ (4.14)} = 8.8591E+007$
 $u = su \text{ (4.1)} = 1.7029732E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$
 $l_b = 300.00$
 $l_d = 2120.262$
 Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$\rho = 1$
 $db = 16.85714$
Mean strength value of all re-bars: $f_y = 625.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

Calculation of μ_1 -

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

$\mu = 1.7245646E-005$
 $\mu = 1.0758E+008$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00220465$
 $N = 27514.027$
 $f_c = 20.00$
 $\alpha (5A.5, TBDY) = 0.002$
Final value of μ : $\mu^* = \text{shear_factor} * \text{Max}(\mu, \mu_c) = 0.0035$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\mu = 0.0035$
 $\mu_e (5.4c) = 0.00$
 $\alpha_e ((5.4d), TBDY) = (\alpha_e1 * A_{col1} + \alpha_e2 * A_{col2} + \alpha_e3 * A_{web}) / A_{sec} = 0.00$
 $\alpha_e1 = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $\alpha_e2 = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $\alpha_e3 = 0$ (grid does not provide confinement)
 $p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$
 $p_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$
 $h_1 = 600.00$
 $A_{s1} = A_{stir1} * n_{s1} = 157.0796$
No stirups, $n_{s1} = 2.00$
 $p_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$
 $h_2 = 600.00$
 $A_{s2} = A_{stir2} * n_{s2} = 157.0796$
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, $n_{s3} = 2.00$

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$
 $p_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$
 $h_1 = 250.00$
 $A_{s1} = A_{stir1} * n_{s1} = 157.0796$
No stirups, $n_{s1} = 2.00$
 $p_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$
 $h_2 = 250.00$

$As_2 = Astir_2 * ns_2 = 157.0796$
 No stirups, $ns_2 = 2.00$
 $ps_{3,y} (web) = (As_3 * h_3 / s_3) / A_c = 0.00$
 $h_3 = 250.00$
 $As_3 = Astir_3 * ns_3 = 157.0796$
 No stirups, $ns_3 = 0.00$

$A_{sec} = 750000.00$

$s_1 = 150.00$

$s_2 = 150.00$

$s_3 = 200.00$

$fy_{we} = 625.00$

$f_{ce} = 20.00$

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

$c =$ confinement factor $= 1.00$

$y_1 = 0.00084854$

$sh_1 = 0.00271532$

$ft_1 = 254.5614$

$fy_1 = 212.1345$

$su_1 = 0.00271532$

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

$lo/lou, min = lb/ld = 0.14149197$

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

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

For calculation of $esu_1_{nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.

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

with $fs_1 = fs = 212.1345$

with $Es_1 = Es = 200000.00$

$y_2 = 0.00084854$

$sh_2 = 0.00271532$

$ft_2 = 254.5614$

$fy_2 = 212.1345$

$su_2 = 0.00271532$

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

$lo/lou, min = lb/lb, min = 0.14149197$

$su_2 = 0.4 * esu_2_{nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu_2_{nominal} = 0.08$,

For calculation of $esu_2_{nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.

y_2, sh_2, ft_2, fy_2 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_2 = fs = 212.1345$

with $Es_2 = Es = 200000.00$

$y_v = 0.00084854$

$sh_v = 0.00271532$

$ft_v = 254.5614$

$fy_v = 212.1345$

$suv = 0.00271532$

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

$lo/lou, min = lb/ld = 0.14149197$

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

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

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

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

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

with $fsv = fs = 212.1345$

with $Esv = Es = 200000.00$

$1 = Asl, ten / (b * d) * (fs_1 / f_c) = 0.04026409$

$2 = Asl, com / (b * d) * (fs_2 / f_c) = 0.04026409$

$v = Asl, mid / (b * d) * (fsv / f_c) = 0.02734113$

and confined core properties:

$$b = 2940.00$$

$$d = 178.00$$

$$d' = 12.00$$

$$fcc (5A.2, TBDY) = 20.00$$

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

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

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.04801038$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.04801038$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.03260121$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$su (4.9) = 0.24303049$$

$$\mu_u = M_{Rc} (4.14) = 1.0758E+008$$

$$u = su (4.1) = 1.7245646E-005$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$

$$l_b = 300.00$$

$$l_d = 2120.262$$

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

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 16.85714$$

Mean strength value of all re-bars: $f_y = 625.00$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of μ_{u2+}

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

$$u = 1.7029732E-005$$

$$\mu_u = 8.8591E+007$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00220465$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, cc) = 0.0035$

The Shear_factor is considered equal to 1 (pure moment strength)

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

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

$$ase ((5.4d), TBDY) = (ase1 * A_{col1} + ase2 * A_{col2} + ase3 * A_{web}) / A_{sec} = 0.00$$

$$ase1 = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$ase2 = 0.00$$

$$sh_2 = 150.00$$

$bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $ase3 = 0$ (grid does not provide confinement)
 $psh,min = \text{Min}(psh,x, psh,y) = 0.00069813$

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x$ (column 1) = $(As1 \cdot h1 / s_1) / Ac = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,x$ (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirups, $ns2 = 2.00$
 $ps3,x$ (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00188496$
 $h3 = 1800.00$
 $As3 = Astir3 \cdot ns3 = 0.00$
 No stirups, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y$ (column 1) = $(As1 \cdot h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,y$ (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirups, $ns2 = 2.00$
 $ps3,y$ (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00$
 $h3 = 250.00$
 $As3 = Astir3 \cdot ns3 = 157.0796$
 No stirups, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 625.00$
 $fce = 20.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c =$ confinement factor = 1.00
 $y1 = 0.00084854$
 $sh1 = 0.00271532$
 $ft1 = 254.5614$
 $fy1 = 212.1345$
 $su1 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/ld = 0.14149197$
 $su1 = 0.4 \cdot esu1_nominal$ ((5.5), TBDY) = 0.032
 From table 5A.1, TBDY: $esu1_nominal = 0.08$,
 For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1 / 1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = fs = 212.1345$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00084854$
 $sh2 = 0.00271532$
 $ft2 = 254.5614$
 $fy2 = 212.1345$
 $su2 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/lb,min = 0.14149197$

$su_2 = 0.4 \cdot esu_{2_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2_nominal} = 0.08$,
 For calculation of $esu_{2_nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 212.1345$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00084854$
 $sh_v = 0.00271532$
 $ft_v = 254.5614$
 $fy_v = 212.1345$
 $suv = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lo_{u,min} = lb/ld = 0.14149197$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = fs = 212.1345$
 with $Es_v = Es = 200000.00$
 $1 = Asl_{ten}/(b \cdot d) \cdot (fs_1/fc) = 0.04026409$
 $2 = Asl_{com}/(b \cdot d) \cdot (fs_2/fc) = 0.04026409$
 $v = Asl_{mid}/(b \cdot d) \cdot (fs_v/fc) = 0.00$

and confined core properties:

$b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 20.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_{ten}/(b \cdot d) \cdot (fs_1/fc) = 0.04801038$
 $2 = Asl_{com}/(b \cdot d) \cdot (fs_2/fc) = 0.04801038$
 $v = Asl_{mid}/(b \cdot d) \cdot (fs_v/fc) = 0.00$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

$su (4.9) = 0.23343312$

$\mu_u = MR_c (4.14) = 8.8591E+007$

$u = su (4.1) = 1.7029732E-005$

 Calculation of ratio lb/ld

 Lap Length: $lb/ld = 0.14149197$

$lb = 300.00$

$ld = 2120.262$

Calculation of lb_{min} according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld_{min} from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$db = 16.85714$

Mean strength value of all re-bars: $fy = 625.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

 Calculation of μ_{u2} -

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$\phi_u = 1.7245646E-005$$

$$\mu = 1.0758E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$\nu = 0.00220465$$

$$N = 27514.027$$

$$f_c = 20.00$$

$$\phi_{co} (5A.5, TBDY) = 0.002$$

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0035$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.0035$$

$$\phi_{we} (5.4c) = 0.00$$

$$\phi_{ase} ((5.4d), TBDY) = (\phi_{ase1} * A_{col1} + \phi_{ase2} * A_{col2} + \phi_{ase3} * A_{web}) / A_{sec} = 0.00$$

$$\phi_{ase1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$\phi_{ase2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$\phi_{ase3} = 0 \text{ (grid does not provide confinement)}$$

$$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.00069813$$

$$\phi_{psh,x} = \phi_{ps1,x} + \phi_{ps2,x} + \phi_{ps3,x} = 0.00356047$$

$$\phi_{ps1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirups, } n_{s1} = 2.00$$

$$\phi_{ps2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirups, } n_{s2} = 2.00$$

$$\phi_{ps3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirups, } n_{s3} = 2.00$$

$$\phi_{psh,y} = \phi_{ps1,y} + \phi_{ps2,y} + \phi_{ps3,y} = 0.00069813$$

$$\phi_{ps1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirups, } n_{s1} = 2.00$$

$$\phi_{ps2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirups, } n_{s2} = 2.00$$

$$\phi_{ps3,y} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

$$\text{No stirups, } n_{s3} = 0.00$$

$$A_{sec} = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 625.00$$

$$f_{ce} = 20.00$$

```

From ((5.A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00084854
sh1 = 0.00271532
ft1 = 254.5614
fy1 = 212.1345
su1 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 212.1345
with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04026409
2 = Asl,com/(b*d)*(fs2/fc) = 0.04026409
v = Asl,mid/(b*d)*(fsv/fc) = 0.02734113
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04801038
2 = Asl,com/(b*d)*(fs2/fc) = 0.04801038
v = Asl,mid/(b*d)*(fsv/fc) = 0.03260121
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->

```


$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

---->

$$\mu_u(4.9) = 0.24303049$$

$$\mu_u = M_{Rc}(4.14) = 1.0758E+008$$

$$u = \mu_u(4.1) = 1.7245646E-005$$

Calculation of ratio l_b/l_d

$$\text{Lap Length: } l_b/l_d = 0.14149197$$

$$l_b = 300.00$$

$$l_d = 2120.262$$

Calculation of l_b ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_d ,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 16.85714$$

Mean strength value of all re-bars: $f_y = 625.00$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 834708.585$

Calculation of Shear Strength at edge 1, $V_{r1} = 834708.585$

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: $V_c = 729988.83$

$$\mu_u/V_u - l_w/2 = 0.00 \leq 0$$

= 1 (normal-weight concrete)

$$f'_c = 20.00, \text{ but } f'_c \cdot 0.5 \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$h = 3000.00$$

$$d = 200.00$$

$$l_w = 250.00$$

$$\mu_u = 3.9108324E-011$$

$$V_u = 4.7331654E-030$$

$$N_u = 27514.027$$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 104719.755$

$V_{s1} = 52359.878$ is calculated for pseudo-Column 1, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 500.00$$

V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$V_{s2} = 52359.878$ is calculated for pseudo-Column 2, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 500.00$$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$V_{s3} = 0.00$ is calculated for web, with:

$$d = 200.00$$

$$A_v = 0.00$$

$$s = 200.00$$

$$f_y = 500.00$$

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: $V_s + V_f \leq 1.7825E+006$
 $b_w = 3000.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 834708.585$
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: $V_c = 729988.83$
 $\mu_u / \mu_u - l_w / 2 = 0.00 \leq 0$
= 1 (normal-weight concrete)
 $f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3 \text{ MPa}$ (22.5.3.1, ACI 318-14)
 $h = 3000.00$
 $d = 200.00$
 $l_w = 250.00$
 $\mu_u = 3.9108324E-011$
 $V_u = 4.7331654E-030$
 $N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 104719.755$

$V_{s1} = 52359.878$ is calculated for pseudo-Column 1, with:

$d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 500.00$

V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17, 10.3.4)

$2(1-s/d) = 0.50$

$V_{s2} = 52359.878$ is calculated for pseudo-Column 2, with:

$d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 500.00$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17, 10.3.4)

$2(1-s/d) = 0.50$

$V_{s3} = 0.00$ is calculated for web, with:

$d = 200.00$
 $A_v = 0.00$
 $s = 200.00$
 $f_y = 500.00$

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: $V_s + V_f \leq 1.7825E+006$
 $b_w = 3000.00$

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: (d)
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
 $\gamma = 0.00069813$

with $\gamma = \rho_{s1} + \rho_{s2} + \rho_{s3}$, being the shear reinf. ratio in a plane perpendicular to the shear axis 3
(pseudo-col.1 $\rho_{s1} = A_{s1} \cdot b_1 / s_1 = (A_{s1} \cdot h_1 / s_1) / A_c = 0.00034907$

$h1 = 250.00$
 $s1 = 150.00$
 total area of hoops perpendicular to shear axis, $As1 = 157.0796$
 (pseudo-col.2 $ps2 = As2*b2/s2 = (As2*h2/s2) / Ac = 0.00034907$
 $h2 = 250.00$
 $s2 = 150.00$
 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:

New material of Primary Member: Concrete Strength, $fc = fc_lower_bound = 20.00$
 New material of Primary Member: Steel Strength, $fs = fs_lower_bound = 500.00$
 Concrete Elasticity, $Ec = 25742.96$
 Steel Elasticity, $Es = 200000.00$
 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
 Smooth Bars
 Ductile Steel
 With Detailing for Earthquake Resistance (including stirrups closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $lb = 300.00$
 No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 828340.466$
 Shear Force, $V2 = -2.8553711E-014$
 Shear Force, $V3 = 30202.562$
 Axial Force, $F = -30954.347$
 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, $DbL = 17.33333$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.01540528$
 $u = y + p = 0.01540528$

- Calculation of y -

$y = (My*Ip)/(EI)_{Eff} = 0.00040528 ((10^{-5}), ASCE 41-17))$
 $My = 1.7117E+009$
 $(EI)_{Eff} = 0.35*Ec*I$ (table 10-5)
 $Ec*I = 1.4480E+016$
 $Ip = 0.5*d = 0.5*(0.8*h) = 1200.00$

Calculation of Yielding Moment My

Calculation of γ and M_y according to Annex 7 -

$y = \text{Min}(y_{\text{ten}}, y_{\text{com}})$
 $y_{\text{ten}} = 4.1973704\text{E-}007$
with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 \cdot f_y \cdot (l_b/d)^{2/3}) = 196.9282$
 $d = 2957.00$
 $y = 0.20667842$
 $A = 0.00879703$
 $B = 0.00456724$
with $p_t = 0.00387573$
 $p_c = 0.00387573$
 $p_v = 0.00083294$
 $N = 30954.347$
 $b = 250.00$
 $\mu = 0.01454177$
 $y_{\text{comp}} = 2.3329189\text{E-}006$
with $f_c = 20.00$
 $E_c = 25742.96$
 $y = 0.20271835$
 $A = 0.00843469$
 $B = 0.00435462$
with $E_s = 200000.00$

Calculation of ratio l_b/d

Lap Length: $l_d/d, \text{min} = 0.17686496$
 $l_b = 300.00$
 $l_d = 1696.209$
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d, min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
 $= 1$
 $db = 16.85714$
Mean strength value of all re-bars: $f_y = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

- Calculation of p -

Considering wall controlled by flexure (shear control ratio ≤ 1),
from table 10-19: $p = 0.015$

with:

- Condition i (shear wall and wall segments)
- $(A_s - A_s') \cdot f_y + P / (t_w \cdot l_w \cdot f_c') = -0.20947028$

$A_s = 0.00$

$A_s' = 6346.017$

$f_y = 500.00$

$P = 30954.347$

$t_w = 250.00$

$l_w = 3000.00$

$f_c' = 20.00$

- $V / (t_w \cdot l_w \cdot f_c'^{0.5}) = 0.10844031$, NOTE: units in lb & in

- Confined Boundary: No

Boundary hoops spacing exceed $8db$ ($s_1 > 8 \cdot db$ or $s_2 > 8 \cdot db$)

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:

$V_{w1} = 251327.412$

$s_1 = 150.00$

Boundary Element 2:

$V_{w2} = 251327.412$

$s_2 = 150.00$
Grid Shear Force, $V_{w3} = 0.00$
Concrete Shear Force, $V_c = 730676.894$
(The variables above have already been given in Shear control ratio calculation)
Mean diameter of all bars, $d_b = 17.33333$
Design Shear Force, $V = 30202.562$

End Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1
At local axis: 2
Integration Section: (d)

Calculation No. 15

wall W1, Floor 1
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)
Analysis: Uniform +X
Check: Shear capacity V_{Rd}
Edge: End
Local Axis: (3)



Start Of Calculation of Shear Capacity for element: wall W1 of floor 1
At local axis: 3
Integration Section: (d)
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, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$
New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$
Concrete Elasticity, $E_c = 25742.96$

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
 Smooth Bars
 Ductile Steel
 With Detailing for Earthquake Resistance (including stirrups closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $l_o = l_b = 300.00$
 No FRP Wrapping

Stepwise Properties

EDGE -A-
 Bending Moment, $M_a = 8.9797E+007$
 Shear Force, $V_a = -30202.562$
 EDGE -B-
 Bending Moment, $M_b = 828340.466$
 Shear Force, $V_b = 30202.562$
 BOTH EDGES
 Axial Force, $F = -30954.347$
 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, $Db_{L,ten} = 17.33333$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 1.7988E+006$
 From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d = 1.7988E+006$

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: $V_c = 730676.894$
 $\mu_u / \mu_u - l_w / 2 = -1472.574 \leq 0$
 = 1 (normal-weight concrete)
 $f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 250.00$
 $d = 2400.00$
 $l_w = 3000.00$
 $\mu_u = 828340.466$
 $V_u = 30202.562$
 $N_u = 30954.347$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0681E+006$
 $V_{s1} = 251327.412$ is calculated for pseudo-Column 1, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 500.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 251327.412$ is calculated for pseudo-Column 2, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 500.00$
 V_{s2} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s3} = 565486.678$ is calculated for web, with:
 $d = 1440.00$
 $A_v = 157079.633$
 $s = 200.00$
 $f_y = 500.00$
 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: $V_s + V_f \leq 1.7825E+006$
 $b_w = 250.00$

 End Of Calculation of Shear Capacity for element: wall W1 of floor 1
 At local axis: 3
 Integration Section: (d)

Calculation No. 16

wall W1, Floor 1
 Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)
 Analysis: Uniform +X
 Check: Chord rotation capacity (ϕ)
 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:
 New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 20.00$
 New material of Primary Member: Steel Strength, $f_s = f_{sm} = 500.00$
 Concrete Elasticity, $E_c = 25742.96$
 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

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 625.00$

#####

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

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = 300.00$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 2.0194839E-028$

EDGE -B-

Shear Force, $V_b = -2.0194839E-028$

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, $V_e/V_r = 0.68720049$

Member Controlled by Flexure ($V_e/V_r < 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 1.2357E+006$
with

$M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 1.8535E+009$

$Mu_{1+} = 1.7546E+009$, 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

$Mu_{1-} = 1.8535E+009$, 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

$M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 1.8535E+009$

$Mu_{2+} = 1.7546E+009$, 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

$Mu_{2-} = 1.8535E+009$, 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_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$\phi_u = 1.1650088E-006$

$Mu = 1.7546E+009$

with full section properties:

$b = 250.00$

$d = 2957.00$
 $d' = 43.00$
 $v = 0.00186094$
 $N = 27514.027$
 $fc = 20.00$
 $co (5A.5, TBDY) = 0.002$
 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: $cu = 0.0035$
 $we (5.4c) = 0.00$
 $ase ((5.4d), TBDY) = (ase1 * Acol1 + ase2 * Acol2 + ase3 * Aweb) / Asec = 0.00$
 $ase1 = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $ase2 = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $ase3 = 0$ (grid does not provide confinement)
 $psh,min = Min(psh,x, psh,y) = 0.00069813$

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x$ (column 1) = $(As1 * h1 / s_1) / Ac = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 * ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,x$ (column 2) = $(As2 * h2 / s_2) / Ac = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 * ns2 = 157.0796$
 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, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y$ (column 1) = $(As1 * h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 * ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,y$ (column 2) = $(As2 * h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 * ns2 = 157.0796$
 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, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 625.00$
 $fce = 20.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c =$ confinement factor = 1.00
 $y1 = 0.00084854$
 $sh1 = 0.00271532$
 $ft1 = 254.5614$
 $fy1 = 212.1345$
 $su1 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with

```

Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 212.1345
with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04110878
2 = Asl,com/(b*d)*(fs2/fc) = 0.04110878
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) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0546449
2 = Asl,com/(b*d)*(fs2/fc) = 0.0546449
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vsy2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.21179234
Mu = MRc (4.14) = 1.7546E+009
u = su (4.1) = 1.1650088E-006

```

Calculation of ratio lb/ld

Lap Length: $l_b/l_d = 0.14149197$

$l_b = 300.00$

$l_d = 2120.262$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$= 1$

$db = 16.85714$

Mean strength value of all re-bars: $f_y = 625.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of μ_1 -

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$\mu = 1.1680845E-006$

$\mu_u = 1.8535E+009$

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$

$v = 0.00186094$

$N = 27514.027$

$f_c = 20.00$

ϕ (5A.5, TBDY) = 0.002

Final value of ϕ_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: $\phi_u = 0.0035$

ϕ_{we} (5.4c) = 0.00

ϕ_{ase} ((5.4d), TBDY) = $(\phi_{ase1} * A_{col1} + \phi_{ase2} * A_{col2} + \phi_{ase3} * A_{web}) / A_{sec} = 0.00$

$\phi_{ase1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$\phi_{ase2} = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$\phi_{ase3} = 0$ (grid does not provide confinement)

$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.00069813$

$\phi_{psh,x} = \phi_{ps1,x} + \phi_{ps2,x} + \phi_{ps3,x} = 0.00356047$

$\phi_{ps1,x}$ (column 1) = $(A_{s1} * h_1 / s_1) / A_c = 0.00083776$

$h_1 = 600.00$

$A_{s1} = A_{stir1} * n_{s1} = 157.0796$

No stirups, $n_{s1} = 2.00$

$\phi_{ps2,x}$ (column 2) = $(A_{s2} * h_2 / s_2) / A_c = 0.00083776$

$h_2 = 600.00$

$A_{s2} = A_{stir2} * n_{s2} = 157.0796$

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, $n_{s3} = 2.00$

$\phi_{psh,y} = \phi_{ps1,y} + \phi_{ps2,y} + \phi_{ps3,y} = 0.00069813$

$\phi_{ps1,y}$ (column 1) = $(A_{s1} * h_1 / s_1) / A_c = 0.00034907$

$h1 = 250.00$
 $As1 = Astir1 * ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,y \text{ (column 2)} = (As2 * h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 * ns2 = 157.0796$
 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, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 625.00$
 $fce = 20.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y1 = 0.00084854$
 $sh1 = 0.00271532$
 $ft1 = 254.5614$
 $fy1 = 212.1345$
 $su1 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/ld = 0.14149197$
 $su1 = 0.4 * esu1_nominal \text{ ((5.5), TBDY)} = 0.032$
 From table 5A.1, TBDY: $esu1_nominal = 0.08$,
 For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1 / 1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = fs = 212.1345$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00084854$
 $sh2 = 0.00271532$
 $ft2 = 254.5614$
 $fy2 = 212.1345$
 $su2 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/lb,min = 0.14149197$
 $su2 = 0.4 * esu2_nominal \text{ ((5.5), TBDY)} = 0.032$
 From table 5A.1, TBDY: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2 / 1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = fs = 212.1345$
 with $Es2 = Es = 200000.00$
 $yv = 0.00084854$
 $shv = 0.00271532$
 $ftv = 254.5614$
 $fyv = 212.1345$
 $suv = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/ld = 0.14149197$
 $suv = 0.4 * esuv_nominal \text{ ((5.5), TBDY)} = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv / 1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv / 1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

```

with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04110878
2 = Asl,com/(b*d)*(fs2/fc) = 0.04110878
v = Asl,mid/(b*d)*(fsv/fc) = 0.00883478
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0546449
2 = Asl,com/(b*d)*(fs2/fc) = 0.0546449
v = Asl,mid/(b*d)*(fsv/fc) = 0.01174386
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.21386777
Mu = MRc (4.14) = 1.8535E+009
u = su (4.1) = 1.1680845E-006

```

Calculation of ratio lb/d

```

Lap Length: lb/d = 0.14149197
lb = 300.00
ld = 2120.262
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 625.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

```

Calculation of Mu2+

```

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.1650088E-006
Mu = 1.7546E+009

```

with full section properties:

```

b = 250.00
d = 2957.00
d' = 43.00
v = 0.00186094
N = 27514.027
fc = 20.00
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 = 150.00

```

```

bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 150.00
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) = 0.00069813

```

```

psh,x = ps1,x+ps2,x+ps3,x = 0.00356047
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00083776
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776
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 = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
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 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 625.00
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00084854
sh1 = 0.00271532
ft1 = 254.5614
fy1 = 212.1345
su1 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345

```

```

su2 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 212.1345
with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04110878
2 = Asl,com/(b*d)*(fs2/fc) = 0.04110878
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) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0546449
2 = Asl,com/(b*d)*(fs2/fc) = 0.0546449
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) = 0.21179234
Mu = MRc (4.14) = 1.7546E+009
u = su (4.1) = 1.1650088E-006

```

Calculation of ratio lb/ld

```

-----
Lap Length: lb/ld = 0.14149197
lb = 300.00
ld = 2120.262
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 625.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399

```

n = 28.00

Calculation of Mu2-

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$\mu = 1.1680845E-006$

$M_u = 1.8535E+009$

with full section properties:

b = 250.00

d = 2957.00

d' = 43.00

$\nu = 0.00186094$

N = 27514.027

$f_c = 20.00$

α (5A.5, TBDY) = 0.002

Final value of μ : $\mu^* = \text{shear_factor} * \text{Max}(\mu, \alpha) = 0.0035$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\mu = 0.0035$

w_e (5.4c) = 0.00

$a_{se}((5.4d), \text{TBDY}) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$

$a_{se1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$a_{se2} = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$a_{se3} = 0$ (grid does not provide confinement)

$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$

$p_{s1,x}$ (column 1) = $(A_{s1} * h_1 / s_1) / A_c = 0.00083776$

$h_1 = 600.00$

$A_{s1} = A_{stir1} * n_{s1} = 157.0796$

No stirups, $n_{s1} = 2.00$

$p_{s2,x}$ (column 2) = $(A_{s2} * h_2 / s_2) / A_c = 0.00083776$

$h_2 = 600.00$

$A_{s2} = A_{stir2} * n_{s2} = 157.0796$

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, $n_{s3} = 2.00$

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$

$p_{s1,y}$ (column 1) = $(A_{s1} * h_1 / s_1) / A_c = 0.00034907$

$h_1 = 250.00$

$A_{s1} = A_{stir1} * n_{s1} = 157.0796$

No stirups, $n_{s1} = 2.00$

$p_{s2,y}$ (column 2) = $(A_{s2} * h_2 / s_2) / A_c = 0.00034907$

$h_2 = 250.00$

$A_{s2} = A_{stir2} * n_{s2} = 157.0796$

No stirups, $n_{s2} = 2.00$

$p_{s3,y}$ (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 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 625.00
fce = 20.00
From ((5.A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00084854
sh1 = 0.00271532
ft1 = 254.5614
fy1 = 212.1345
su1 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 212.1345
with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04110878
2 = Asl,com/(b*d)*(fs2/fc) = 0.04110878
v = Asl,mid/(b*d)*(fsv/fc) = 0.00883478
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0546449

```

$$2 = A_{sl,com}/(b*d)*(f_s2/f_c) = 0.0546449$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.01174386$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u(4.9) = 0.21386777$$

$$M_u = M_{Rc}(4.14) = 1.8535E+009$$

$$u = s_u(4.1) = 1.1680845E-006$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$

$$l_b = 300.00$$

$$l_d = 2120.262$$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 16.85714$$

Mean strength value of all re-bars: $f_y = 625.00$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 1.7981E+006$

Calculation of Shear Strength at edge 1, $V_{r1} = 1.7981E+006$

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: $V_c = 729988.83$

$$M_u/V_u - l_w/2 = 0.00 \leq 0$$

= 1 (normal-weight concrete)

$$f_c' = 20.00, \text{ but } f_c'^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$h = 250.00$$

$$d = 2400.00$$

$$l_w = 3000.00$$

$$M_u = 1.6689249E-009$$

$$V_u = 2.0194839E-028$$

$$N_u = 27514.027$$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0681E+006$

$V_{s1} = 251327.412$ is calculated for pseudo-Column 1, with:

$$d = 480.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 500.00$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 251327.412$ is calculated for pseudo-Column 2, with:

$$d = 480.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 500.00$$

V_{s2} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s3} = 565486.678$ is calculated for web, with:

$$d = 1440.00$$

$$A_v = 157079.633$$

$$s = 200.00$$

fy = 500.00

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: $V_s + V_f \leq 1.7825E+006$

bw = 250.00

Calculation of Shear Strength at edge 2, $V_{r2} = 1.7981E+006$

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: $V_c = 729988.83$

$\mu_u/\mu_u - l_w/2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

h = 250.00

d = 240.00

$l_w = 3000.00$

$\mu_u = 1.6689249E-009$

$V_u = 2.0194839E-028$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 1.0681E+006$

$V_{s1} = 251327.412$ is calculated for pseudo-Column 1, with:

d = 480.00

$A_v = 157079.633$

s = 150.00

fy = 500.00

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 251327.412$ is calculated for pseudo-Column 2, with:

d = 480.00

$A_v = 157079.633$

s = 150.00

fy = 500.00

V_{s2} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s3} = 565486.678$ is calculated for web, with:

d = 1440.00

$A_v = 157079.633$

s = 200.00

fy = 500.00

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: $V_s + V_f \leq 1.7825E+006$

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: rcwrs

Constant Properties

Knowledge Factor, = 1.00

Mean strength values are used for both shear and moment calculations.

Consequently:

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 20.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

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
New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 625.00$ 
#####
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
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length  $l_o = 300.00$ 
No FRP Wrapping
-----

Stepwise Properties
-----
At local axis: 2
EDGE -A-
Shear Force,  $V_a = -4.7331654E-030$ 
EDGE -B-
Shear Force,  $V_b = 4.7331654E-030$ 
BOTH EDGES
Axial Force,  $F = -27514.027$ 
Longitudinal Reinforcement Area Distribution (in 2 divisions)
  -Tension:  $A_{slt} = 0.00$ 
  -Compression:  $A_{slc} = 6346.017$ 
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 ,  $V_e/V_r = 0.08592175$ 
Member Controlled by Flexure ( $V_e/V_r < 1$ )
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n = 71719.625$ 
with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 1.0758E+008$ 
 $\mu_{u1+} = 8.8591E+007$ , is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
 $\mu_{u1-} = 1.0758E+008$ , is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 1.0758E+008$ 
 $\mu_{u2+} = 8.8591E+007$ , is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
 $\mu_{u2-} = 1.0758E+008$ , 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:
 $\phi_u = 1.7029732E-005$ 
 $\mu_u = 8.8591E+007$ 
-----

with full section properties:
 $b = 3000.00$ 
 $d = 208.00$ 

```

$d' = 42.00$
 $v = 0.00220465$
 $N = 27514.027$
 $fc = 20.00$
 $co (5A.5, TBDY) = 0.002$
 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: $cu = 0.0035$
 $we (5.4c) = 0.00$
 $ase ((5.4d), TBDY) = (ase1 * Acol1 + ase2 * Acol2 + ase3 * Aweb) / Asec = 0.00$
 $ase1 = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $ase2 = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $ase3 = 0$ (grid does not provide confinement)
 $psh, min = Min(psh, x, psh, y) = 0.00069813$

$psh, x = ps1, x + ps2, x + ps3, x = 0.00356047$
 $ps1, x (column 1) = (As1 * h1 / s_1) / Ac = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 * ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2, x (column 2) = (As2 * h2 / s_2) / Ac = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 * ns2 = 157.0796$
 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, $ns3 = 2.00$

$psh, y = ps1, y + ps2, y + ps3, y = 0.00069813$
 $ps1, y (column 1) = (As1 * h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 * ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2, y (column 2) = (As2 * h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 * ns2 = 157.0796$
 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, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$

$fywe = 625.00$
 $fce = 20.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c =$ confinement factor $= 1.00$

$y1 = 0.00084854$
 $sh1 = 0.00271532$
 $ft1 = 254.5614$
 $fy1 = 212.1345$
 $su1 = 0.00271532$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor $= 1.00$

```

lo/lou,min = lb/d = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 212.1345
with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04026409
2 = Asl,com/(b*d)*(fs2/fc) = 0.04026409
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) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04801038
2 = Asl,com/(b*d)*(fs2/fc) = 0.04801038
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) = 0.23343312
Mu = MRc (4.14) = 8.8591E+007
u = su (4.1) = 1.7029732E-005

```

Calculation of ratio lb/d

Lap Length: lb/d = 0.14149197

$l_b = 300.00$
 $l_d = 2120.262$
 Calculation of l_b , min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d , min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $f_y = 625.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

Calculation of μ_1 -

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:
 $\mu = 1.7245646E-005$
 $\mu_u = 1.0758E+008$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00220465$
 $N = 27514.027$
 $f_c = 20.00$
 α_1 (5A.5, TBDY) = 0.002
 Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\mu_u = 0.0035$
 μ_w (5.4c) = 0.00
 α_1 ((5.4d), TBDY) = $(\alpha_1 * A_{col1} + \alpha_2 * A_{col2} + \alpha_3 * A_{web}) / A_{sec} = 0.00$
 $\alpha_1 = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $\alpha_2 = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $\alpha_3 = 0$ (grid does not provide confinement)
 $p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$
 $p_{s1,x}$ (column 1) = $(A_{s1} * h_1 / s_1) / A_c = 0.00083776$
 $h_1 = 600.00$
 $A_{s1} = A_{stir1} * n_{s1} = 157.0796$
 No stirups, $n_{s1} = 2.00$
 $p_{s2,x}$ (column 2) = $(A_{s2} * h_2 / s_2) / A_c = 0.00083776$
 $h_2 = 600.00$
 $A_{s2} = A_{stir2} * n_{s2} = 157.0796$
 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, $n_{s3} = 2.00$

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$
 $p_{s1,y}$ (column 1) = $(A_{s1} * h_1 / s_1) / A_c = 0.00034907$
 $h_1 = 250.00$

$As1 = Astir1 * ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,y \text{ (column 2)} = (As2 * h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 * ns2 = 157.0796$
 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, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 625.00$
 $fce = 20.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y1 = 0.00084854$
 $sh1 = 0.00271532$
 $ft1 = 254.5614$
 $fy1 = 212.1345$
 $su1 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/ld = 0.14149197$
 $su1 = 0.4 * esu1_nominal \text{ ((5.5), TBDY)} = 0.032$
 From table 5A.1, TBDY: $esu1_nominal = 0.08$,
 For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1 / 1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = fs = 212.1345$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00084854$
 $sh2 = 0.00271532$
 $ft2 = 254.5614$
 $fy2 = 212.1345$
 $su2 = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/lb,min = 0.14149197$
 $su2 = 0.4 * esu2_nominal \text{ ((5.5), TBDY)} = 0.032$
 From table 5A.1, TBDY: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2 / 1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = fs = 212.1345$
 with $Es2 = Es = 200000.00$
 $yv = 0.00084854$
 $shv = 0.00271532$
 $ftv = 254.5614$
 $fyv = 212.1345$
 $suv = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/ld = 0.14149197$
 $suv = 0.4 * esuv_nominal \text{ ((5.5), TBDY)} = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv / 1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv / 1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 212.1345$

with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.04026409$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.04026409$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.02734113$
and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 20.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.04801038$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.04801038$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.03260121$
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
--->
 $su (4.9) = 0.24303049$
 $Mu = MR_c (4.14) = 1.0758E+008$
 $u = su (4.1) = 1.7245646E-005$

Calculation of ratio l_b/d

Lap Length: $l_b/d = 0.14149197$
 $l_b = 300.00$
 $l_d = 2120.262$
Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 16.85714$
Mean strength value of all re-bars: $f_y = 625.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

Calculation of Mu_{2+}

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.7029732E-005$
 $Mu = 8.8591E+007$

with full section properties:
 $b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00220465$
 $N = 27514.027$
 $f_c = 20.00$
 $co (5A.5, TBDY) = 0.002$
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: $cu = 0.0035$
 $w_e (5.4c) = 0.00$
 $ase ((5.4d), TBDY) = (ase1*A_{col1} + ase2*A_{col2} + ase3*A_{web})/A_{sec} = 0.00$
 $ase1 = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$

```

ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 150.00
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) = 0.00069813

```

```

psh,x = ps1,x+ps2,x+ps3,x = 0.00356047
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00083776
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776
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 = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
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 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 625.00
fce = 20.00

```

From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00

```

y1 = 0.00084854
sh1 = 0.00271532
ft1 = 254.5614
fy1 = 212.1345
su1 = 0.00271532

```

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.14149197

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.

with fs1 = fs = 212.1345

with Es1 = Es = 200000.00

```

y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532

```

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.14149197$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 212.1345$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00084854$
 $sh_v = 0.00271532$
 $ft_v = 254.5614$
 $fy_v = 212.1345$
 $suv = 0.00271532$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.14149197$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 212.1345$
 with $Es_v = Es = 200000.00$
 $1 = A_{sl,ten}/(b*d) * (fs_1/f_c) = 0.04026409$
 $2 = A_{sl,com}/(b*d) * (fs_2/f_c) = 0.04026409$
 $v = A_{sl,mid}/(b*d) * (fsv/f_c) = 0.00$
 and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 20.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d) * (fs_1/f_c) = 0.04801038$
 $2 = A_{sl,com}/(b*d) * (fs_2/f_c) = 0.04801038$
 $v = A_{sl,mid}/(b*d) * (fsv/f_c) = 0.00$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.23343312$
 $Mu = MR_c (4.14) = 8.8591E+007$
 $u = su (4.1) = 1.7029732E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$
 $l_b = 300.00$
 $l_d = 2120.262$
 Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $fy = 625.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

Calculation of Mu2-

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\mu = 1.7245646E-005$$

$$Mu = 1.0758E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00220465$$

$$N = 27514.027$$

$$f_c = 20.00$$

$$cc \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu: \mu = \text{shear_factor} * \text{Max}(\mu_c, cc) = 0.0035$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu_c = 0.0035$$

$$w_e \text{ (5.4c)} = 0.00$$

$$ase \text{ ((5.4d), TBDY)} = (ase1 * A_{col1} + ase2 * A_{col2} + ase3 * A_{web}) / A_{sec} = 0.00$$

$$ase1 = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$ase2 = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$ase3 = 0 \text{ (grid does not provide confinement)}$$

$$psh_{min} = \text{Min}(psh_x, psh_y) = 0.00069813$$

$$psh_x = ps1_x + ps2_x + ps3_x = 0.00356047$$

$$ps1_x \text{ (column 1)} = (As1 * h1 / s_1) / A_c = 0.00083776$$

$$h1 = 600.00$$

$$As1 = Astir1 * ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2_x \text{ (column 2)} = (As2 * h2 / s_2) / A_c = 0.00083776$$

$$h2 = 600.00$$

$$As2 = Astir2 * ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3_x \text{ (web)} = (As3 * h3 / s_3) / A_c = 0.00188496$$

$$h3 = 1800.00$$

$$As3 = Astir3 * ns3 = 0.00$$

$$\text{No stirups, } ns3 = 2.00$$

$$psh_y = ps1_y + ps2_y + ps3_y = 0.00069813$$

$$ps1_y \text{ (column 1)} = (As1 * h1 / s_1) / A_c = 0.00034907$$

$$h1 = 250.00$$

$$As1 = Astir1 * ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2_y \text{ (column 2)} = (As2 * h2 / s_2) / A_c = 0.00034907$$

$$h2 = 250.00$$

$$As2 = Astir2 * ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3_y \text{ (web)} = (As3 * h3 / s_3) / A_c = 0.00$$

$$h3 = 250.00$$

$$As3 = Astir3 * ns3 = 157.0796$$

$$\text{No stirups, } ns3 = 0.00$$

$$A_{sec} = 750000.00$$

$$s_1 = 150.00$$

```

s_2 = 150.00
s_3 = 200.00
fywe = 625.00
fce = 20.00
From ((5A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00084854
sh1 = 0.00271532
ft1 = 254.5614
fy1 = 212.1345
su1 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 0.14149197
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 212.1345
with Es1 = Es = 200000.00
y2 = 0.00084854
sh2 = 0.00271532
ft2 = 254.5614
fy2 = 212.1345
su2 = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14149197
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 212.1345
with Es2 = Es = 200000.00
yv = 0.00084854
shv = 0.00271532
ftv = 254.5614
fyv = 212.1345
suv = 0.00271532
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 0.14149197
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 212.1345
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04026409
2 = Asl,com/(b*d)*(fs2/fc) = 0.04026409
v = Asl,mid/(b*d)*(fsv/fc) = 0.02734113
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04801038
2 = Asl,com/(b*d)*(fs2/fc) = 0.04801038

```

$$v = A_{sl, mid} / (b * d) * (f_{sv} / f_c) = 0.03260121$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.24303049$$

$$M_u = M_{Rc} (4.14) = 1.0758E+008$$

$$u = s_u (4.1) = 1.7245646E-005$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14149197$

$$l_b = 300.00$$

$$l_d = 2120.262$$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 16.85714$$

Mean strength value of all re-bars: $f_y = 625.00$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 834708.585$

Calculation of Shear Strength at edge 1, $V_{r1} = 834708.585$

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: $V_c = 729988.83$

$$M_u / V_u - l_w / 2 = 0.00 \leq 0$$

= 1 (normal-weight concrete)

$$f_c' = 20.00, \text{ but } f_c^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$h = 3000.00$$

$$d = 200.00$$

$$l_w = 250.00$$

$$M_u = 3.9108324E-011$$

$$V_u = 4.7331654E-030$$

$$N_u = 27514.027$$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 104719.755$

$V_{s1} = 52359.878$ is calculated for pseudo-Column 1, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 500.00$$

V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$V_{s2} = 52359.878$ is calculated for pseudo-Column 2, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 500.00$$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$V_{s3} = 0.00$ is calculated for web, with:

$$d = 200.00$$

$$A_v = 0.00$$

s = 200.00

fy = 500.00

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 <= 1.7825E+006

bw = 3000.00

Calculation of Shear Strength at edge 2, Vr2 = 834708.585

From (22.5.1.1) and 11.5.4.3, ACI 318-14: Vr2 = Vn < 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: Vc = 729988.83

Mu/Vu-lw/2 = 0.00 <= 0

= 1 (normal-weight concrete)

fc' = 20.00, but fc'^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)

h = 3000.00

d = 200.00

lw = 250.00

Mu = 3.9108324E-011

Vu = 4.7331654E-030

Nu = 27514.027

From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 + Vs3 = 104719.755

Vs1 = 52359.878 is calculated for pseudo-Column 1, with:

d = 200.00

Av = 157079.633

s = 150.00

fy = 500.00

Vs1 has been multiplied by 2(1-s/d) (s>d/2, according to ASCE 41-17,10.3.4)

2(1-s/d) = 0.50

Vs2 = 52359.878 is calculated for pseudo-Column 2, with:

d = 200.00

Av = 157079.633

s = 150.00

fy = 500.00

Vs2 has been multiplied by 2(1-s/d) (s>d/2, according to ASCE 41-17,10.3.4)

2(1-s/d) = 0.50

Vs3 = 0.00 is calculated for web, with:

d = 200.00

Av = 0.00

s = 200.00

fy = 500.00

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 <= 1.7825E+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: (d)

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

$$n = 0.00069813$$

with $n = ps1 + ps2 + ps3$, being the shear reinf. ratio in a plane perpendicular to the shear axis 2

$$(\text{pseudo-col.1 } ps1 = As1 \cdot b1 / s1 = (As1 \cdot h1 / s1) / Ac = 0.00034907$$

$$h1 = 250.00$$

$$s1 = 150.00$$

$$\text{total area of hoops perpendicular to shear axis, } As1 = 157.0796$$

$$(\text{pseudo-col.2 } ps2 = As2 \cdot b2 / s2 = (As2 \cdot h2 / s2) / Ac = 0.00034907$$

$$h2 = 250.00$$

$$s2 = 150.00$$

$$\text{total area of hoops perpendicular to shear axis, } As2 = 157.0796$$

$$(\text{grid } ps3 = As3 \cdot b3 / s3 = (As3 \cdot h3 / s3) / Ac = 0.00$$

$$h3 = 250.00$$

$$s3 = 200.00$$

$$\text{total area of hoops perpendicular to shear axis, } As3 = 0.00$$

$$\text{total section area, } Ac = 750000.00$$

Consequently:

New material of Primary Member: Concrete Strength, $fc = fc_{\text{lower_bound}} = 20.00$

New material of Primary Member: Steel Strength, $fs = fs_{\text{lower_bound}} = 500.00$

Concrete Elasticity, $Ec = 25742.96$

Steel Elasticity, $Es = 200000.00$

Total Height, $H_{\text{tot}} = 3000.00$

Edges Width, $W_{\text{edg}} = 250.00$

Edges Height, $H_{\text{edg}} = 600.00$

Web Width, $W_{\text{web}} = 250.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Primary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_b = 300.00$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = -5.2916137E-010$

Shear Force, $V2 = -2.8553711E-014$

Shear Force, $V3 = 30202.562$

Axial Force, $F = -30954.347$

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, $DbL = 17.20$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.01576811$

$$u = y + p = 0.01576811$$

- Calculation of y -

$$y = (My \cdot I_p) / (EI)_{\text{Eff}} = 0.00076811 \text{ ((10-5), ASCE 41-17))}$$

$$My = 1.1264E+008$$

$$(EI)_{\text{Eff}} = 0.35 \cdot Ec \cdot I \text{ (table 10-5)}$$

$$Ec \cdot I = 1.0056E+014$$

$$I_p = 0.5 \cdot d = 0.5 \cdot (0.8 \cdot h) = 240.00$$

Calculation of Yielding Moment M_y

Calculation of ρ_y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 6.2595522E-006$
with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25*f_y*(l_b/l_d)^{2/3}) = 196.9282$
 $d = 208.00$
 $y = 0.24373973$
 $A = 0.0104218$
 $B = 0.00636362$
with $p_t = 0.00379609$
 $p_c = 0.00379609$
 $p_v = 0.00257772$
 $N = 30954.347$
 $b = 3000.00$
 $\rho = 0.20192308$
 $y_{comp} = 2.7995026E-005$
with $f_c = 20.00$
 $E_c = 25742.96$
 $y = 0.24015952$
 $A = 0.00999254$
 $B = 0.00611172$
with $E_s = 200000.00$

Calculation of ratio l_b/l_d

Lap Length: $l_{d,min} = 0.17686496$
 $l_b = 300.00$
 $l_d = 1696.209$
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
 $= 1$
 $db = 16.85714$
Mean strength value of all re-bars: $f_y = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

- Calculation of ρ_p -

Considering wall controlled by flexure (shear control ratio ≤ 1),
from table 10-19: $\rho_p = 0.015$

with:

- Condition i (shear wall and wall segments)
- $(A_s - A_s')*f_y + P)/(t_w*l_w*f_c') = -0.20947028$
 $A_s = 0.00$
 $A_s' = 6346.017$
 $f_y = 500.00$
 $P = 30954.347$
 $t_w = 3000.00$
 $l_w = 250.00$
 $f_c = 20.00$
- $V/(t_w*l_w*f_c'^{0.5}) = 1.0252022E-019$, NOTE: units in lb & in
- Confined Boundary: No
Boundary hoops spacing exceed $8db$ ($s_1 > 8*db$ or $s_2 > 8*db$)
Boundary Trans. Reinf. does not exceed 50% of ACI 318 provision ($V_w1 + V_w2 > 0.50*(V - V_c - V_w3)$)
With
Boundary Element 1:

Vw1 = 104719.755

s1 = 150.00

Boundary Element 2:

Vw2 = 104719.755

s2 = 150.00

Grid Shear Force, Vw3 = 0.00

Concrete Shear Force, Vc = 137875.693

(The variables above have already been given in Shear control ratio calculation)

Mean diameter of all bars, db = 17.33333

Design Shear Force, V = 2.8553711E-014

End Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (d)