

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 VRd

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, $\gamma = 0.85$

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

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

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$
Total Height, $H_{tot} = 3000.00$
Edges Width, $W_{edg} = 250.00$
Edges Height, $H_{edg} = 600.00$
Web Width, $W_{web} = 250.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_o/l_{ou,min} = l_b/l_d \geq 1$)
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, $M_a = -5.9539400E-011$
Shear Force, $V_a = 4.8629285E-015$
EDGE -B-
Bending Moment, $M_b = 7.2444996E-011$
Shear Force, $V_b = -4.8629285E-015$
BOTH EDGES
Axial Force, $F = -29003.068$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl,t} = 0.00$
-Compression: $A_{sl,c} = 6346.017$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten} = 2368.761$
-Compression: $A_{sl,com} = 2368.761$
-Middle: $A_{sl,mid} = 1608.495$
Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 17.20$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = V_n = 177499.237$
From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c^{0.5} \cdot h \cdot d = 208822.632$

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: $V_c = 125046.828$
 $\mu_u/V_u - l_w/2 = 12118.528 > 0$
= 1 (normal-weight concrete)
 $f_c' = 16.00$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 3000.00$
 $d = 200.00$
 $l_w = 250.00$
 $\mu_u = 5.9539400E-011$
 $V_u = 4.8629285E-015$
 $N_u = 29003.068$
From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$
 $V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 $V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$

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:

$$d = 200.00$$

$$A_v = 0.00$$

$$s = 200.00$$

$$f_y = 400.00$$

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

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

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

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

$$b_w = 3000.00$$

End Of Calculation of Shear Capacity 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: rcrws

Constant Properties

Knowledge Factor, $\gamma = 0.85$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

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Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

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

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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, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = -6.3108872E-029$

EDGE -B-

Shear Force, $V_b = 6.3108872E-029$

BOTH EDGES

Axial Force, $F = -27514.027$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 0.00$

-Compression: $As_c = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t, ten} = 2865.133$

-Compression: $As_{c, com} = 2865.133$

-Middle: $As_{mid} = 0.00$

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

Calculation of Shear Capacity ratio , $V_e/V_r = 2.43595$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 4.0910E+006$

with

$M_{pr1} = \text{Max}(Mu_{1+} , Mu_{1-}) = 6.1366E+009$

$Mu_{1+} = 5.5677E+009$, 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

$Mu_{1-} = 6.1366E+009$, 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

$M_{pr2} = \text{Max}(Mu_{2+} , Mu_{2-}) = 6.1366E+009$

$Mu_{2+} = 5.5677E+009$, 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

$Mu_{2-} = 6.1366E+009$, 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:

$\phi_u = 1.1598028E-005$

Mu = 5.5677E+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: $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0035$

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

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

we (5.4c) = 0.00

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

ase1 = 0.00

sh_1 = 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 = $\text{Min}(psh,x, psh,y) = 0.00069813$

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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 stirrups, ns1 = 2.00

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

h2 = 600.00

As2 = $Astir2*ns2 = 157.0796$

No stirrups, ns2 = 2.00

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

h3 = 1800.00

As3 = $Astir3*ns3 = 0.00$

No stirrups, 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 stirrups, ns1 = 2.00

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

h2 = 250.00

As2 = $Astir2*ns2 = 157.0796$

No stirrups, ns2 = 2.00

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

h3 = 250.00

As3 = $Astir3*ns3 = 157.0796$

No stirrups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 555.55

fce = 20.00

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

c = confinement factor = 1.00

y1 = 0.00231479

$$sh1 = 0.008$$

$$ft1 = 666.66$$

$$fy1 = 555.55$$

$$su1 = 0.032$$

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

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

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

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

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

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

$$\text{with } fs1 = fs = 555.55$$

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

$$y2 = 0.00231479$$

$$sh2 = 0.008$$

$$ft2 = 666.66$$

$$fy2 = 555.55$$

$$su2 = 0.032$$

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

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

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

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

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

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

$$\text{with } fs2 = fs = 555.55$$

$$\text{with } Es2 = Es = 200000.00$$

$$yv = 0.00231479$$

$$shv = 0.008$$

$$ftv = 666.66$$

$$fyv = 555.55$$

$$suv = 0.032$$

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

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

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

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

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

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

$$\text{with } fsv = fs = 555.55$$

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

$$1 = Asl,ten / (b * d) * (fs1 / fc) = 0.10765806$$

$$2 = Asl,com / (b * d) * (fs2 / fc) = 0.10765806$$

$$v = Asl,mid / (b * d) * (fsv / fc) = 0.00$$

and confined core properties:

$$b = 190.00$$

$$d = 2927.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 20.00$$

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

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

$$1 = Asl,ten / (b * d) * (fs1 / fc) = 0.14310722$$

$$2 = Asl,com / (b * d) * (fs2 / fc) = 0.14310722$$

$$v = Asl,mid / (b * d) * (fsv / fc) = 0.00$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$su (4.9) = 0.06692943$$

$$\begin{aligned} \text{Mu} &= \text{MRc} (4.14) = 5.5677\text{E}+009 \\ u &= \text{su} (4.1) = 1.1598028\text{E}-005 \end{aligned}$$

Calculation of ratio l_b/l_d

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

Calculation of Mu_1 -

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

$$\begin{aligned} u &= 1.1691922\text{E}-005 \\ \text{Mu} &= 6.1366\text{E}+009 \end{aligned}$$

with full section properties:

$$\begin{aligned} b &= 250.00 \\ d &= 2957.00 \\ d' &= 43.00 \\ v &= 0.00186094 \\ N &= 27514.027 \\ f_c &= 20.00 \\ c_o (5A.5, \text{TBDY}) &= 0.002 \\ \text{Final value of } c_u: c_u^* &= \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0035 \\ \text{The Shear_factor is considered equal to 1 (pure moment strength)} \\ \text{From (5.4b), TBDY: } c_u &= 0.0035 \\ w_e (5.4c) &= 0.00 \\ a_{se} ((5.4d), \text{TBDY}) &= (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00 \\ a_{se1} &= 0.00 \\ sh_1 &= 150.00 \\ bo_1 &= 190.00 \\ ho_1 &= 540.00 \\ bi2_1 &= 655400.00 \\ a_{se2} &= 0.00 \\ sh_2 &= 150.00 \\ bo_2 &= 190.00 \\ ho_2 &= 540.00 \\ bi2_2 &= 655400.00 \\ a_{se3} &= 0 \text{ (grid does not provide confinement)} \\ p_{sh,min} &= \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813 \\ \text{Expression ((5.4d), TBDY) for } p_{sh,min} &\text{ has been multiplied by 0.3 according to 15.7.1.3 for members without} \\ &\text{earthquake detailing (90}^\circ \text{ closed stirrups)} \end{aligned}$$

$$\begin{aligned} p_{sh,x} &= p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047 \\ p_{s1,x} \text{ (column 1)} &= (A_{s1} * h_1 / s_1) / A_c = 0.00083776 \\ h_1 &= 600.00 \\ A_{s1} &= A_{stir1} * n_{s1} = 157.0796 \\ \text{No stirrups, } n_{s1} &= 2.00 \\ p_{s2,x} \text{ (column 2)} &= (A_{s2} * h_2 / s_2) / A_c = 0.00083776 \\ h_2 &= 600.00 \\ A_{s2} &= A_{stir2} * n_{s2} = 157.0796 \\ \text{No stirrups, } n_{s2} &= 2.00 \\ p_{s3,x} \text{ (web)} &= (A_{s3} * h_3 / s_3) / A_c = 0.00188496 \\ h_3 &= 1800.00 \\ A_{s3} &= A_{stir3} * n_{s3} = 0.00 \\ \text{No stirrups, } n_{s3} &= 2.00 \end{aligned}$$

$$\begin{aligned} p_{sh,y} &= p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813 \\ p_{s1,y} \text{ (column 1)} &= (A_{s1} * h_1 / s_1) / A_c = 0.00034907 \\ h_1 &= 250.00 \\ A_{s1} &= A_{stir1} * n_{s1} = 157.0796 \\ \text{No stirrups, } n_{s1} &= 2.00 \\ p_{s2,y} \text{ (column 2)} &= (A_{s2} * h_2 / s_2) / A_c = 0.00034907 \\ h_2 &= 250.00 \end{aligned}$$

$As_2 = Astir_2 * ns_2 = 157.0796$
No stirups, $ns_2 = 2.00$
 $ps_{3,y}(\text{web}) = (As_3 * h_3 / s_3) / Ac = 0.00$
 $h_3 = 250.00$
 $As_3 = Astir_3 * ns_3 = 157.0796$
No stirups, $ns_3 = 0.00$

 $A_{sec} = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fy_{we} = 555.55$
 $f_{ce} = 20.00$

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

$y_1 = 0.00231479$
 $sh_1 = 0.008$
 $ft_1 = 666.66$
 $fy_1 = 555.55$
 $su_1 = 0.032$

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

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

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

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

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

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

with $fs_1 = fs = 555.55$

with $Es_1 = Es = 200000.00$

$y_2 = 0.00231479$
 $sh_2 = 0.008$
 $ft_2 = 666.66$
 $fy_2 = 555.55$
 $su_2 = 0.032$

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

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

$su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,

For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $fsy_2 = fs_2 / 1.2$, from table 5.1, TBDY.

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

with $fs_2 = fs = 555.55$

with $Es_2 = Es = 200000.00$

$y_v = 0.00231479$
 $sh_v = 0.008$
 $ft_v = 666.66$
 $fy_v = 555.55$
 $suv = 0.032$

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

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

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

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

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

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

y_v, sh_v, ft_v, fy_v , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fsv = fs = 555.55$

with $Es_v = Es = 200000.00$

$1 = Asl, \text{ten} / (b * d) * (fs_1 / fc) = 0.10765806$

$2 = Asl, \text{com} / (b * d) * (fs_2 / fc) = 0.10765806$

$v = Asl, \text{mid} / (b * d) * (fsv / fc) = 0.02313704$

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 = $Asl,ten/(b*d)*(fs1/fc) = 0.14310722$
2 = $Asl,com/(b*d)*(fs2/fc) = 0.14310722$
v = $Asl,mid/(b*d)*(fsv/fc) = 0.0307555$

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

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

--->
su (4.9) = 0.07442258
Mu = MRc (4.14) = 6.1366E+009
u = su (4.1) = 1.1691922E-005

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu2+

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

u = 1.1598028E-005
Mu = 5.5677E+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

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

$ps_{2,x}$ (column 2) = $(As_2 \cdot h_2 / s_2) / Ac = 0.00083776$
h2 = 600.00
As2 = Astir2 * ns2 = 157.0796
No stirups, ns2 = 2.00
 $ps_{3,x}$ (web) = $(As_3 \cdot h_3 / s_3) / Ac = 0.00188496$
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) = $(As_1 \cdot h_1 / s_1) / Ac = 0.00034907$
h1 = 250.00
As1 = Astir1 * ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = $(As_2 \cdot h_2 / s_2) / Ac = 0.00034907$
h2 = 250.00
As2 = Astir2 * ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,y (web) = $(As_3 \cdot h_3 / s_3) / Ac = 0.00$
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 = 555.55
fce = 20.00
From ((5.A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00231479
sh1 = 0.008
ft1 = 666.66
fy1 = 555.55
su1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su1 = 0.4 * esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.
with fs1 = fs = 555.55
with Es1 = Es = 200000.00
y2 = 0.00231479
sh2 = 0.008
ft2 = 666.66
fy2 = 555.55
su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4 * esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.
with fs2 = fs = 555.55
with Es2 = Es = 200000.00
yv = 0.00231479
shv = 0.008
ftv = 666.66
fyv = 555.55

suv = 0.032

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

lo/lou,min = lb/d = 1.00

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

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

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

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

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

with fsv = fs = 555.55

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.10765806

2 = Asl,com/(b*d)*(fs2/fc) = 0.10765806

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) = 0.14310722

2 = Asl,com/(b*d)*(fs2/fc) = 0.14310722

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) = 0.06692943

Mu = MRc (4.14) = 5.5677E+009

u = su (4.1) = 1.1598028E-005

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu2-

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

u = 1.1691922E-005

Mu = 6.1366E+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

$$bi2_1 = 655400.00$$

$$ase2 = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

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

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

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

$$h1 = 600.00$$

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

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

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

$$h2 = 600.00$$

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

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

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

$$h3 = 1800.00$$

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

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

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

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

$$h1 = 250.00$$

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

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

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

$$h2 = 250.00$$

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

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

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

$$h3 = 250.00$$

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

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

$$Asec = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$fywe = 555.55$$

$$fce = 20.00$$

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

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

$$y1 = 0.00231479$$

$$sh1 = 0.008$$

$$ft1 = 666.66$$

$$fy1 = 555.55$$

$$su1 = 0.032$$

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

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

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

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.

$$\text{with } fs1 = fs = 555.55$$

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

$$y2 = 0.00231479$$

$$sh2 = 0.008$$

$$ft2 = 666.66$$

$$fy2 = 555.55$$

$$su_2 = 0.032$$

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

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

$$su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,

For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.

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

$$\text{with } fs_2 = fs = 555.55$$

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

$$yv = 0.00231479$$

$$shv = 0.008$$

$$ftv = 666.66$$

$$fyv = 555.55$$

$$suv = 0.032$$

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

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

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

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

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

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

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.

$$\text{with } fsv = fs = 555.55$$

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

$$1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.10765806$$

$$2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.10765806$$

$$v = Asl_{mid}/(b*d) * (fsv/fc) = 0.02313704$$

and confined core properties:

$$b = 190.00$$

$$d = 2927.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 20.00$$

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

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

$$1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.14310722$$

$$2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.14310722$$

$$v = Asl_{mid}/(b*d) * (fsv/fc) = 0.0307555$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < vs_{y2}$ - LHS eq.(4.5) is satisfied

--->

$$su (4.9) = 0.07442258$$

$$\mu = MRc (4.14) = 6.1366E+009$$

$$u = su (4.1) = 1.1691922E-005$$

Calculation of ratio lb/ld

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

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 1.6794E+006$

Calculation of Shear Strength at edge 1, $V_{r1} = 1.6794E+006$

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) ' 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)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$M_u = 3.2196245E-010$

$V_u = 6.3108872E-029$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 949449.618$

$V_{s1} = 223399.91$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 444.44$

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

$V_{s2} = 223399.91$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 444.44$

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

$V_{s3} = 502649.798$ is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 444.44$

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, $V_{r2} = 1.6794E+006$

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)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$M_u = 3.2196245E-010$

$V_u = 6.3108872E-029$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 949449.618$

$V_{s1} = 223399.91$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 444.44$

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

$V_{s2} = 223399.91$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 444.44$

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

$V_{s3} = 502649.798$ is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 444.44$

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, $\phi = 0.85$
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 16.00$
Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 400.00$
Concrete Elasticity, $E_c = 21019.039$
Steel Elasticity, $E_s = 200000.00$

Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, $f_s = 1.25 * f_{sm} = 500.00$

Total Height, $H_{tot} = 3000.00$
Edges Width, $W_{edg} = 250.00$
Edges Height, $H_{edg} = 600.00$
Web Width, $W_{web} = 250.00$
Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.00
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_o/l_{ou,min} >= 1$)
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = 0.00$
EDGE -B-
Shear Force, $V_b = 0.00$
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 , $V_e/V_r = 0.28750647$

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

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

with
 $M_{pr1} = \text{Max}(M_{u1+} , M_{u1-}) = 3.1796E+008$
 $M_{u1+} = 2.4327E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
 $M_{u1-} = 3.1796E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(M_{u2+} , M_{u2-}) = 3.1796E+008$
 $M_{u2+} = 2.4327E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
 $M_{u2-} = 3.1796E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

Calculation of M_{u1+}

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

$\phi_u = 0.00019144$

$M_u = 2.4327E+008$

with full section properties:

$b = 3000.00$

$d = 208.00$

$d' = 42.00$

$v = 0.00275581$

$N = 27514.027$

$f_c = 16.00$

ϕ_c (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: $\phi_u = 0.0035$

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)

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

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

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

$p_{s1,x}$ (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 stirrups, $n_{s1} = 2.00$

$p_{s2,x}$ (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 stirrups, $n_{s2} = 2.00$

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

$h_3 = 1800.00$

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

No stirrups, $n_{s3} = 2.00$

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

ps1,y (column 1) = $(As1 \cdot h1 / s_1) / Ac = 0.00034907$
h1 = 250.00
As1 = Astir1 * 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 * ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,y (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00$
h3 = 250.00
As3 = Astir3 * ns3 = 157.0796
No stirups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 500.00

fce = 16.00

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

c = confinement factor = 1.00

y1 = 0.00208333

sh1 = 0.00805

ft1 = 600.00

fy1 = 500.00

su1 = 0.03226667

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

lo/lou,min = lb/lb = 1.00

su1 = $0.4 \cdot esu1_nominal$ ((5.5), TBDY) = 0.03226667

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

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

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

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

y2 = 0.00208333

sh2 = 0.00805

ft2 = 600.00

fy2 = 500.00

su2 = 0.03226667

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

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

su2 = $0.4 \cdot esu2_nominal$ ((5.5), TBDY) = 0.03226667

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

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

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

with fs2 = fs = 500.00

with Es2 = Es = 200000.00

yv = 0.00208333

shv = 0.00805

ftv = 600.00

fyv = 500.00

suv = 0.03226667

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

lo/lou,min = lb/lb = 1.00

suv = $0.4 \cdot esuv_nominal$ ((5.5), TBDY) = 0.03226667

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

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

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

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

with $f_{sv} = f_s = 500.00$

with $E_{sv} = E_s = 200000.00$

$1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.11862785$

$2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.11862785$

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

and confined core properties:

$b = 2940.00$

$d = 178.00$

$d' = 12.00$

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

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

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

$1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.14145031$

$2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.14145031$

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

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

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

--->

$su \text{ (4.9)} = 0.18965884$

$Mu = MRc \text{ (4.14)} = 2.4327E+008$

$u = su \text{ (4.1)} = 0.00019144$

Calculation of ratio l_b/d

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

Calculation of Mu_1 -

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

$u = 0.00019712$

$Mu = 3.1796E+008$

with full section properties:

$b = 3000.00$

$d = 208.00$

$d' = 42.00$

$v = 0.00275581$

$N = 27514.027$

$f_c = 16.00$

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

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 (5.4c) = 0.00

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

$ase1 = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$ase2 = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$ase3 = 0$ (grid does not provide confinement)

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

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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 = 500.00
fce = 16.00

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

y1 = 0.00208333
sh1 = 0.00805

ft1 = 600.00
fy1 = 500.00

su1 = 0.03226667

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

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

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

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

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

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

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

y2 = 0.00208333

sh2 = 0.00805

ft2 = 600.00

fy2 = 500.00

su2 = 0.03226667

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

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

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

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

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

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

with $f_{s2} = f_s = 500.00$
 with $E_{s2} = E_s = 200000.00$
 $y_v = 0.00208333$
 $sh_v = 0.00805$
 $ft_v = 600.00$
 $fy_v = 500.00$
 $suv = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 1.00$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08066667$,
 considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and 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 $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = f_s = 500.00$
 with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b * d) * (f_{s1}/f_c) = 0.11862785$
 $2 = A_{sl,com}/(b * d) * (f_{s2}/f_c) = 0.11862785$
 $v = A_{sl,mid}/(b * d) * (f_{sv}/f_c) = 0.08055366$
 and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 16.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b * d) * (f_{s1}/f_c) = 0.14145031$
 $2 = A_{sl,com}/(b * d) * (f_{s2}/f_c) = 0.14145031$
 $v = A_{sl,mid}/(b * d) * (f_{sv}/f_c) = 0.09605114$
 Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)
 --->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.2130262$
 $Mu = MR_c (4.14) = 3.1796E+008$
 $u = su (4.1) = 0.00019712$

 Calculation of ratio l_b/l_d

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

Calculation of Mu_{2+}

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

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

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $f_c = 16.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu^* = 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

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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 = 500.00

fce = 16.00

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

c = confinement factor = 1.00

y1 = 0.00208333

sh1 = 0.00805

ft1 = 600.00

fy1 = 500.00

su1 = 0.03226667

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

lo/lou,min = lb/lb = 1.00

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

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

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

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

with $f_{s1} = f_s = 500.00$
 with $E_{s1} = E_s = 200000.00$
 $y_2 = 0.00208333$
 $sh_2 = 0.00805$
 $ft_2 = 600.00$
 $fy_2 = 500.00$
 $su_2 = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_{b,min} = 1.00$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08066667$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{s2} = f_s = 500.00$
 with $E_{s2} = E_s = 200000.00$
 $y_v = 0.00208333$
 $sh_v = 0.00805$
 $ft_v = 600.00$
 $fy_v = 500.00$
 $suv = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 1.00$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08066667$,
 considering characteristic value $fsyv = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = f_s = 500.00$
 with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b*d) * (f_{s1}/f_c) = 0.11862785$
 $2 = A_{sl,com}/(b*d) * (f_{s2}/f_c) = 0.11862785$
 $v = A_{sl,mid}/(b*d) * (f_{sv}/f_c) = 0.00$
 and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 16.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d) * (f_{s1}/f_c) = 0.14145031$
 $2 = A_{sl,com}/(b*d) * (f_{s2}/f_c) = 0.14145031$
 $v = A_{sl,mid}/(b*d) * (f_{sv}/f_c) = 0.00$
 Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)
 --->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.18965884$
 $Mu = MRc (4.14) = 2.4327E+008$
 $u = su (4.1) = 0.00019144$

 Calculation of ratio l_b/l_d

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

Calculation of Mu_2 -

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

$$u = 0.00019712$$

$$Mu = 3.1796E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

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

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

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

$$w_e(5.4c) = 0.00$$

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

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

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

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

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

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

$$h_1 = 600.00$$

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

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

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

$$h_2 = 600.00$$

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

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

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

$$h_3 = 1800.00$$

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

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

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

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

$$h_1 = 250.00$$

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

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

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

$$h_2 = 250.00$$

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

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

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

$$h_3 = 250.00$$

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

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

$$A_{sec} = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 500.00$$

$$f_{ce} = 16.00$$

From ((5.A.5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y1 = 0.00208333$
 $sh1 = 0.00805$
 $ft1 = 600.00$
 $fy1 = 500.00$
 $su1 = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/ld = 1.00$
 $su1 = 0.4 * esu1_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,
 For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = fs = 500.00$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00208333$
 $sh2 = 0.00805$
 $ft2 = 600.00$
 $fy2 = 500.00$
 $su2 = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/lb,min = 1.00$
 $su2 = 0.4 * esu2_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esu2_nominal = 0.08066667$,
 For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = fs = 500.00$
 with $Es2 = Es = 200000.00$
 $yv = 0.00208333$
 $shv = 0.00805$
 $ftv = 600.00$
 $fyv = 500.00$
 $suv = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/ld = 1.00$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 500.00$
 with $Esv = Es = 200000.00$
 $1 = Asl,ten / (b * d) * (fs1 / fc) = 0.11862785$
 $2 = Asl,com / (b * d) * (fs2 / fc) = 0.11862785$
 $v = Asl,mid / (b * d) * (fsv / fc) = 0.08055366$
 and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $fcc (5A.2, TBDY) = 16.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl,ten / (b * d) * (fs1 / fc) = 0.14145031$
 $2 = Asl,com / (b * d) * (fs2 / fc) = 0.14145031$
 $v = Asl,mid / (b * d) * (fsv / fc) = 0.09605114$
 Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)

--->

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

--->

$$\mu_u(4.9) = 0.2130262$$

$$M_u = M_{Rc}(4.14) = 3.1796E+008$$

$$u = \mu_u(4.1) = 0.00019712$$

Calculation of ratio l_b/d

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

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 737278.61$

Calculation of Shear Strength at edge 1, $V_{r1} = 737278.61$

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

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

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

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

= 1 (normal-weight concrete)

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

$$h = 3000.00$$

$$d = 200.00$$

$$l_w = 250.00$$

$$M_u = 1.4551920E-011$$

$$V_u = 0.00$$

$$N_u = 27514.027$$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

$V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 400.00$$

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

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

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 400.00$$

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:

$$d = 200.00$$

$$A_v = 0.00$$

$$s = 200.00$$

$$f_y = 400.00$$

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

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

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

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

$$b_w = 3000.00$$

Calculation of Shear Strength at edge 2, $V_{r2} = 737278.61$

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

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

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

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

= 1 (normal-weight concrete)

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

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$\mu_u = 1.4551920E-011$

$V_u = 0.00$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

$V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

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

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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:

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 400.00$

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

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

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

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

$b_w = 3000.00$

End Of Calculation of Shear Capacity 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, $\gamma = 0.85$

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 $\rho_n = \rho_{s1} + \rho_{s2} + \rho_{s3}$, being the shear reinf. ratio in a plane perpendicular to the shear axis 3

(pseudo-col.1 $\rho_{s1} = A_{s1} \cdot b_1 / s_1 = (A_{s1} \cdot h_1 / s_1) / A_c = 0.00034907$

$h_1 = 250.00$

$s_1 = 150.00$

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

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

$h_2 = 250.00$

$s_2 = 150.00$

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

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

$h_3 = 250.00$

$s_3 = 200.00$

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

total section area, $A_c = 750000.00$

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_b/l_d >= 1$)

No FRP Wrapping

Stepwise Properties

Axial Force, $F = -29003.068$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{sl} = 0.00$

-Compression: $A_{slc} = 6346.017$

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, $DbL = 17.33333$

Considering wall controlled by Shear (shear control ratio > 1),

interstorey drift provided values are calculated

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

from table 10-20: $u = 0.00470588$

with:

- Condition i (shear wall and wall segments)

- $(A_s - A_s') * f_y + P) / (t_w * l_w * f_c) = -0.20911698$

$A_s = 0.00$

$A_s' = 6346.017$

$f_y = 400.00$

$P = 29003.068$

$t_w = 250.00$

$l_w = 3000.00$

$f_c = 16.00$

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

At local axis: 2

Integration Section: (a)

Calculation No. 3

wall W1, Floor 1

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

Analysis: Uniform +X

Check: Shear capacity VR_d

Edge: Start

Local Axis: (3)



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

At local axis: 3

Integration Section: (a)

Section Type: rcrws

Constant Properties

Knowledge Factor, $\gamma = 0.85$

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

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

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 6.7641E+007$

Shear Force, $V_a = -22635.166$

EDGE -B-

Bending Moment, $M_b = 276085.688$

Shear Force, $V_b = 22635.166$

BOTH EDGES

Axial Force, $F = -29003.068$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

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

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

Longitudinal Reinforcement Area Distribution (in 3 divisions)

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

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

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

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

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = V_n = 1.2475E+006$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c^{0.5} \cdot h \cdot d = 1.4676E+006$

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: $V_c = 613117.18$

$\mu_u / \nu_u - l_w / 2 = 1488.331 > 0$

= 1 (normal-weight concrete)

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

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 6.7641E+007$

$\nu_u = 22635.166$

$N_u = 29003.068$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$

$V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

$V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

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

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 400.00$

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

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

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

$b_w = 250.00$

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

At local axis: 3

Integration Section: (a)

Calculation No. 4

wall W1, Floor 1

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

Analysis: Uniform +X

Check: Chord rotation capacity (ϕ)

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: rcwsw

Constant Properties

Knowledge Factor, $\phi = 0.85$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

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

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

#####

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, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = -6.3108872E-029$

EDGE -B-

Shear Force, $V_b = 6.3108872E-029$

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: $As_{t,com} = 2865.133$

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

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

Calculation of Shear Capacity ratio , $V_e/V_r = 2.43595$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 4.0910E+006$
with

$M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 6.1366E+009$

$\mu_{u1+} = 5.5677E+009$, 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

$\mu_{u1-} = 6.1366E+009$, 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

$M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 6.1366E+009$

$\mu_{u2+} = 5.5677E+009$, 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

$\mu_{u2-} = 6.1366E+009$, 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_u according to 4.1, Biskinis/Fardis 2013:

$\mu_u = 1.1598028E-005$

$M_u = 5.5677E+009$

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$

$v = 0.00186094$

$N = 27514.027$

$f_c = 20.00$

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

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

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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*ns1 = 157.0796

No stirrups, ns1 = 2.00

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

h2 = 600.00

As2 = Astir2*ns2 = 157.0796

No stirrups, ns2 = 2.00

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

h3 = 1800.00

As3 = Astir3*ns3 = 0.00

No stirrups, 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*ns1 = 157.0796

No stirrups, ns1 = 2.00

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

h2 = 250.00

As2 = Astir2*ns2 = 157.0796

No stirrups, ns2 = 2.00

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

h3 = 250.00

As3 = Astir3*ns3 = 157.0796

No stirrups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 555.55

fce = 20.00

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

c = confinement factor = 1.00

y1 = 0.00231479

sh1 = 0.008

ft1 = 666.66

fy1 = 555.55

su1 = 0.032

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

lo/lou,min = lb/ld = 1.00

su1 = $0.4 \cdot esu1_nominal$ ((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 = 555.55

with Es1 = Es = 200000.00

y2 = 0.00231479

sh2 = 0.008

ft2 = 666.66

fy2 = 555.55

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

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

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

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

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered

characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

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

with fs2 = fs = 555.55

with Es2 = Es = 200000.00

yv = 0.00231479

shv = 0.008

ftv = 666.66

fyv = 555.55

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 1.00

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

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

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

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered

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

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

with fsv = fs = 555.55

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.10765806

2 = Asl,com/(b*d)*(fs2/fc) = 0.10765806

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) = 0.14310722

2 = Asl,com/(b*d)*(fs2/fc) = 0.14310722

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) = 0.06692943

Mu = MRc (4.14) = 5.5677E+009

u = su (4.1) = 1.1598028E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

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

u = 1.1691922E-005

Mu = 6.1366E+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)

$psh,min = Min(psh,x, psh,y) = 0.00069813$

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

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

$h1 = 600.00$

$As1 = Astir1 * ns1 = 157.0796$

No stirrups, $ns1 = 2.00$

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

$h2 = 600.00$

$As2 = Astir2 * ns2 = 157.0796$

No stirrups, $ns2 = 2.00$

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

$h3 = 1800.00$

$As3 = Astir3 * ns3 = 0.00$

No stirrups, $ns3 = 2.00$

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

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

$h1 = 250.00$

$As1 = Astir1 * ns1 = 157.0796$

No stirrups, $ns1 = 2.00$

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

$h2 = 250.00$

$As2 = Astir2 * ns2 = 157.0796$

No stirrups, $ns2 = 2.00$

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

$h3 = 250.00$

$As3 = Astir3 * ns3 = 157.0796$

No stirrups, $ns3 = 0.00$

 $Asec = 750000.00$

$s_1 = 150.00$

$s_2 = 150.00$

$s_3 = 200.00$

$fywe = 555.55$

$fce = 20.00$

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

$c =$ confinement factor = 1.00

$y1 = 0.00231479$

$sh1 = 0.008$

$ft1 = 666.66$

$fy1 = 555.55$

$su1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

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

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

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

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

with fs1 = fs = 555.55

with Es1 = Es = 200000.00

y2 = 0.00231479

sh2 = 0.008

ft2 = 666.66

fy2 = 555.55

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

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

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

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

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

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

with fs2 = fs = 555.55

with Es2 = Es = 200000.00

yv = 0.00231479

shv = 0.008

ftv = 666.66

fyv = 555.55

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

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

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

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

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

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

with fsv = fs = 555.55

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.10765806

2 = Asl,com/(b*d)*(fs2/fc) = 0.10765806

v = Asl,mid/(b*d)*(fsv/fc) = 0.02313704

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) = 0.14310722

2 = Asl,com/(b*d)*(fs2/fc) = 0.14310722

v = Asl,mid/(b*d)*(fsv/fc) = 0.0307555

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.07442258

Mu = MRc (4.14) = 6.1366E+009

u = su (4.1) = 1.1691922E-005

Calculation of ratio lb/d

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

Calculation of μ_{2+}

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

$$\mu = 1.1598028E-005$$

$$\mu_{2+} = 5.5677E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00186094$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

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

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

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

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

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

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

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

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

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

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

$$h_1 = 600.00$$

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

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

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

$$h_2 = 600.00$$

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

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

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

$$h_3 = 1800.00$$

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

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

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

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

$$h_1 = 250.00$$

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

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

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

$$h_2 = 250.00$$

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

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

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

$$h_3 = 250.00$$

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

No stirups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 555.55

fce = 20.00

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

c = confinement factor = 1.00

y1 = 0.00231479

sh1 = 0.008

ft1 = 666.66

fy1 = 555.55

su1 = 0.032

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

lo/lou,min = lb/d = 1.00

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

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

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

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

with fs1 = fs = 555.55

with Es1 = Es = 200000.00

y2 = 0.00231479

sh2 = 0.008

ft2 = 666.66

fy2 = 555.55

su2 = 0.032

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

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

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

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

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

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

with fs2 = fs = 555.55

with Es2 = Es = 200000.00

yv = 0.00231479

shv = 0.008

ftv = 666.66

fyv = 555.55

suv = 0.032

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

lo/lou,min = lb/d = 1.00

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

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

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

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

with fsv = fs = 555.55

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.10765806

2 = Asl,com/(b*d)*(fs2/fc) = 0.10765806

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

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

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

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.14310722$$

$$2 = Asl,com/(b*d)*(fs2/fc) = 0.14310722$$

$$v = Asl,mid/(b*d)*(fsv/fc) = 0.00$$

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

--->

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

--->

$$su \text{ (4.9)} = 0.06692943$$

$$Mu = MRc \text{ (4.14)} = 5.5677E+009$$

$$u = su \text{ (4.1)} = 1.1598028E-005$$

Calculation of ratio l_b/l_d

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

Calculation of Mu_2

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

$$u = 1.1691922E-005$$

$$Mu = 6.1366E+009$$

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)

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

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

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

$$ase1 = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$ase2 = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

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

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

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

$$h1 = 600.00$$

$$As1 = Astir1*ns1 = 157.0796$$

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

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

$$h2 = 600.00$$

$$As2 = Astir2*ns2 = 157.0796$$

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

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

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 (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 = 555.55
fce = 20.00

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

y1 = 0.00231479
sh1 = 0.008
ft1 = 666.66
fy1 = 555.55
su1 = 0.032

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

lo/lou,min = lb/d = 1.00

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

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

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

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

with fs1 = fs = 555.55

with Es1 = Es = 200000.00

y2 = 0.00231479
sh2 = 0.008
ft2 = 666.66
fy2 = 555.55
su2 = 0.032

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

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

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

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

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

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

with fs2 = fs = 555.55

with Es2 = Es = 200000.00

yv = 0.00231479
shv = 0.008
ftv = 666.66
fyv = 555.55
suv = 0.032

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

lo/lou,min = lb/d = 1.00

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

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

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

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

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

with $fsv = fs = 555.55$

with $Esv = Es = 200000.00$

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.10765806$$

$$2 = Asl,com/(b*d)*(fs2/fc) = 0.10765806$$

$$v = Asl,mid/(b*d)*(fsv/fc) = 0.02313704$$

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

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.14310722$$

$$2 = Asl,com/(b*d)*(fs2/fc) = 0.14310722$$

$$v = Asl,mid/(b*d)*(fsv/fc) = 0.0307555$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

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

$$su (4.9) = 0.07442258$$

$$Mu = MRc (4.14) = 6.1366E+009$$

$$u = su (4.1) = 1.1691922E-005$$

Calculation of ratio lb/d

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

Calculation of Shear Strength $Vr = \text{Min}(Vr1, Vr2) = 1.6794E+006$

Calculation of Shear Strength at edge 1, $Vr1 = 1.6794E+006$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $Vr1 = Vn < 0.83 * fc^{0.5} * h * d$

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: $Vc = 729988.83$

$$Mu/Vu - lw/2 = 0.00 \leq 0$$

= 1 (normal-weight concrete)

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

$$h = 250.00$$

$$d = 2400.00$$

$$lw = 3000.00$$

$$Mu = 3.2196245E-010$$

$$Vu = 6.3108872E-029$$

$$Nu = 27514.027$$

From (11.5.4.8), ACI 318-14: $Vs = Vs1 + Vs2 + Vs3 = 949449.618$

$Vs1 = 223399.91$ is calculated for pseudo-Column 1, with:

$$d = 480.00$$

$$Av = 157079.633$$

$$s = 150.00$$

$$fy = 444.44$$

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

$Vs2 = 223399.91$ is calculated for pseudo-Column 2, with:

$$d = 480.00$$

$$Av = 157079.633$$

$$s = 150.00$$

$f_y = 444.44$

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

$V_{s3} = 502649.798$ is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 444.44$

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, $V_{r2} = 1.6794E+006$

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)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$M_u = 3.2196245E-010$

$V_u = 6.3108872E-029$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 949449.618$

$V_{s1} = 223399.91$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 444.44$

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

$V_{s2} = 223399.91$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 444.44$

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

$V_{s3} = 502649.798$ is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 444.44$

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 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, = 0.85

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

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

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

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

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

#####

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = 0.00$

EDGE -B-

Shear Force, $V_b = 0.00$

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 , $V_e/V_r = 0.28750647$

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

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

with

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

$M_{u1+} = 2.4327E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination

$M_{u1-} = 3.1796E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination

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

$M_{u2+} = 2.4327E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination

$M_{u2-} = 3.1796E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

Calculation of M_{u1+}

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

u = 0.00019144
Mu = 2.4327E+008

with full section properties:

b = 3000.00

d = 208.00

d' = 42.00

v = 0.00275581

N = 27514.027

fc = 16.00

co (5A.5, TBDY) = 0.002

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

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

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

we (5.4c) = 0.00

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

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

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

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

h1 = 600.00

As1 = $A_{stir1} * ns1 = 157.0796$

No stirrups, ns1 = 2.00

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

h2 = 600.00

As2 = $A_{stir2} * ns2 = 157.0796$

No stirrups, ns2 = 2.00

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

h3 = 1800.00

As3 = $A_{stir3} * ns3 = 0.00$

No stirrups, 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 = $A_{stir1} * ns1 = 157.0796$

No stirrups, ns1 = 2.00

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

h2 = 250.00

As2 = $A_{stir2} * ns2 = 157.0796$

No stirrups, ns2 = 2.00

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

h3 = 250.00

As3 = $A_{stir3} * ns3 = 157.0796$

No stirrups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 500.00

fce = 16.00

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

c = confinement factor = 1.00

$y1 = 0.00208333$
 $sh1 = 0.00805$
 $ft1 = 600.00$
 $fy1 = 500.00$
 $su1 = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/d = 1.00$
 $su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,
 For calculation of $esu1_nominal$ and $y1, sh1,ft1,fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, 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 $fs1 = fs = 500.00$
 with $Es1 = Es = 200000.00$

$y2 = 0.00208333$
 $sh2 = 0.00805$
 $ft2 = 600.00$
 $fy2 = 500.00$
 $su2 = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/lb,min = 1.00$
 $su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esu2_nominal = 0.08066667$,
 For calculation of $esu2_nominal$ and $y2, sh2,ft2,fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = fs = 500.00$
 with $Es2 = Es = 200000.00$

$yv = 0.00208333$
 $shv = 0.00805$
 $ftv = 600.00$
 $fyv = 500.00$
 $suv = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/d = 1.00$
 $suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv,ftv,fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 500.00$
 with $Esv = Es = 200000.00$

$1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00$

and confined core properties:

$b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $fcc (5A.2, TBDY) = 16.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00$

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

--->
 $v < vs,c$ - RHS eq.(4.5) is satisfied
 --->

su (4.9) = 0.18965884
Mu = MRc (4.14) = 2.4327E+008
u = su (4.1) = 0.00019144

Calculation of ratio lb/l_d

Adequate Lap Length: lb/l_d >= 1

Calculation of Mu1-

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

u = 0.00019712
Mu = 3.1796E+008

with full section properties:

b = 3000.00
d = 208.00
d' = 42.00
v = 0.00275581
N = 27514.027
fc = 16.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0035
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0035
we (5.4c) = 0.00
ase ((5.4d), TBDY) = (ase1*Acol1+ase2*Acol2+ase3*Aweb)/Asec = 0.00
ase1 = 0.00
sh_1 = 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

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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 = 500.00

fce = 16.00

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

c = confinement factor = 1.00

y1 = 0.00208333

sh1 = 0.00805

ft1 = 600.00

fy1 = 500.00

su1 = 0.03226667

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

lo/lou,min = lb/d = 1.00

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

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

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

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

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

y2 = 0.00208333

sh2 = 0.00805

ft2 = 600.00

fy2 = 500.00

su2 = 0.03226667

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

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

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

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

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

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

with fs2 = fs = 500.00

with Es2 = Es = 200000.00

yv = 0.00208333

shv = 0.00805

ftv = 600.00

fyv = 500.00

suv = 0.03226667

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

lo/lou,min = lb/d = 1.00

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

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

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

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

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

with fsv = fs = 500.00

with Esv = Es = 200000.00

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

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

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.08055366$$

and confined core properties:

$$b = 2940.00$$

$$d = 178.00$$

$$d' = 12.00$$

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

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

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

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.14145031$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.14145031$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.09605114$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

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

--->

$$s_u (4.9) = 0.2130262$$

$$M_u = M_{Rc} (4.14) = 3.1796E+008$$

$$u = s_u (4.1) = 0.00019712$$

Calculation of ratio l_b/d

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

Calculation of M_{u2+}

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

$$u = 0.00019144$$

$$M_u = 2.4327E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

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

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

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

$$w_e (5.4c) = 0.00$$

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

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi_{2,1} = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi_{2,2} = 655400.00$$

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

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

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

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

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

$$h_1 = 600.00$$

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

No stirups, 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 = 500.00
fce = 16.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00208333
sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00

$f_{yv} = 500.00$
 $s_{uv} = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 1.00$
 $s_{uv} = 0.4 * e_{suv_nominal} ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $e_{suv_nominal} = 0.08066667$,
 considering characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $e_{suv_nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = f_s = 500.00$
 with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.11862785$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.11862785$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.00$
 and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 16.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.14145031$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.14145031$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.00$
 Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)
 --->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied
 --->
 $s_u (4.9) = 0.18965884$
 $M_u = M_{Rc} (4.14) = 2.4327E+008$
 $u = s_u (4.1) = 0.00019144$

 Calculation of ratio l_b/l_d

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

Calculation of M_u2 -

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

$u = 0.00019712$
 $M_u = 3.1796E+008$

 with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $f_c = 16.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of c_u : $c_u^* = \text{shear_factor} * \text{Max}(c_u, cc) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.0035$
 $w_e (5.4c) = 0.00$
 $ase ((5.4d), TBDY) = (ase1 * A_{col1} + ase2 * A_{col2} + ase3 * A_{web}) / A_{sec} = 0.00$
 $ase1 = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$

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

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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 stirrups, ns1 = 2.00

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

h2 = 600.00

As2 = Astir2*ns2 = 157.0796

No stirrups, ns2 = 2.00

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

h3 = 1800.00

As3 = Astir3*ns3 = 0.00

No stirrups, 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 stirrups, ns1 = 2.00

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

h2 = 250.00

As2 = Astir2*ns2 = 157.0796

No stirrups, ns2 = 2.00

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

h3 = 250.00

As3 = Astir3*ns3 = 157.0796

No stirrups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 500.00

fce = 16.00

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

c = confinement factor = 1.00

y1 = 0.00208333

sh1 = 0.00805

ft1 = 600.00

fy1 = 500.00

su1 = 0.03226667

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

lo/lou,min = lb/ld = 1.00

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

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

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

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

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

y2 = 0.00208333

sh2 = 0.00805

ft2 = 600.00

$$f_y2 = 500.00$$

$$s_u2 = 0.03226667$$

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

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

$$s_u2 = 0.4 * e_{su2,nominal} ((5.5), TBDY) = 0.03226667$$

From table 5A.1, TBDY: $e_{su2,nominal} = 0.08066667$,

For calculation of $e_{su2,nominal}$ and y_2, sh_2, ft_2, f_y2 , it is considered
characteristic value $f_{sy2} = f_s2/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, f_y1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } f_{s2} = f_s = 500.00$$

$$\text{with } E_{s2} = E_s = 200000.00$$

$$y_v = 0.00208333$$

$$sh_v = 0.00805$$

$$f_{tv} = 600.00$$

$$f_{yv} = 500.00$$

$$s_{uv} = 0.03226667$$

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

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

$$s_{uv} = 0.4 * e_{suv,nominal} ((5.5), TBDY) = 0.03226667$$

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

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

For calculation of $e_{suv,nominal}$ and $y_v, sh_v, f_{tv}, f_{yv}$, it is considered
characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, f_y1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } f_{sv} = f_s = 500.00$$

$$\text{with } E_{sv} = E_s = 200000.00$$

$$1 = A_{sl,ten}/(b*d) * (f_{s1}/f_c) = 0.11862785$$

$$2 = A_{sl,com}/(b*d) * (f_{s2}/f_c) = 0.11862785$$

$$v = A_{sl,mid}/(b*d) * (f_{sv}/f_c) = 0.08055366$$

and confined core properties:

$$b = 2940.00$$

$$d = 178.00$$

$$d' = 12.00$$

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

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

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

$$1 = A_{sl,ten}/(b*d) * (f_{s1}/f_c) = 0.14145031$$

$$2 = A_{sl,com}/(b*d) * (f_{s2}/f_c) = 0.14145031$$

$$v = A_{sl,mid}/(b*d) * (f_{sv}/f_c) = 0.09605114$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

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

--->

$$s_u (4.9) = 0.2130262$$

$$\mu_u = M_{Rc} (4.14) = 3.1796E+008$$

$$u = s_u (4.1) = 0.00019712$$

Calculation of ratio l_b/l_d

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

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 737278.61$

Calculation of Shear Strength at edge 1, $V_{r1} = 737278.61$

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

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

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

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

= 1 (normal-weight concrete)

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

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$M_u = 1.4551920E-011$

$V_u = 0.00$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

$V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

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

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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:

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 400.00$

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

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

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

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

$b_w = 3000.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 737278.61$

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

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

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

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

= 1 (normal-weight concrete)

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

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$M_u = 1.4551920E-011$

$V_u = 0.00$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

$V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

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

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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:

$$d = 200.00$$

$$Av = 0.00$$

$$s = 200.00$$

$$fy = 400.00$$

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

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

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

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

$$bw = 3000.00$$

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

At local axis: 2

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

At local axis: 3

Integration Section: (a)

Section Type: rcrcws

Constant Properties

Knowledge Factor, $\gamma = 0.85$

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

(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:

Existing material of Secondary Member: Concrete Strength, $fc = fc_lower_bound = 16.00$

Existing material of Secondary Member: Steel Strength, $fs = fs_lower_bound = 400.00$

Concrete Elasticity, $Ec = 21019.039$

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, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($lb/d \geq 1$)

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = -5.9539400E-011$
Shear Force, $V2 = 4.8629285E-015$
Shear Force, $V3 = -22635.166$
Axial Force, $F = -29003.068$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 0.00$
-Compression: $A_{sc} = 6346.017$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten} = 2368.761$
-Compression: $A_{sc,com} = 2368.761$
-Middle: $A_{st,mid} = 1608.495$
Mean Diameter of Tension Reinforcement, $DbL = 17.20$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_{,R} = \rho \cdot u = 0.0032804$
 $u = \rho + p = 0.00385929$

- Calculation of ρ -

$\rho = (M_y \cdot I_p) / (E I)_{Eff} = 0.00185929$ ((10-5), ASCE 41-17))
 $M_y = 2.2263E+008$
 $(E I)_{Eff} = 0.35 \cdot E_c \cdot I$ (table 10-5)
 $E_c \cdot I = 8.2106E+013$
 $I_p = 0.5 \cdot d = 0.5 \cdot (0.8 \cdot h) = 240.00$

Calculation of Yielding Moment M_y

Calculation of ρ and M_y according to Annex 7 -

$\rho = \text{Min}(\rho_{ten}, \rho_{com})$
 $\rho_{ten} = 1.2994376E-005$
with $f_y = 400.00$
 $d = 208.00$
 $\rho = 0.26003492$
 $A = 0.0102861$
 $B = 0.00622792$
with $p_t = 0.00379609$
 $p_c = 0.00379609$
 $p_v = 0.00257772$
 $N = 29003.068$
 $b = 3000.00$
 $\rho = 0.20192308$
 $\rho_{comp} = 2.5442826E-005$
with $f_c = 16.00$
 $E_c = 21019.039$
 $\rho = 0.25891127$
 $A = 0.01000029$
 $B = 0.00611172$
with $E_s = 200000.00$

Calculation of ratio l_b/d

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

- Calculation of p -

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

- Condition i (shear wall and wall segments)
- $(A_s - A_s') \cdot f_y + P) / (t_w \cdot l_w \cdot f_c') = -0.20911698$
 - $A_s = 0.00$
 - $A_s' = 6346.017$
 - $f_y = 400.00$
 - $P = 29003.068$
 - $t_w = 3000.00$
 - $l_w = 250.00$
 - $f_c = 16.00$
- $V / (t_w \cdot l_w \cdot f_c'^{0.5}) = 1.9520901E-020$, 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:
 - $V_{w1} = 83775.804$
 - $s_1 = 150.00$
- Boundary Element 2:
 - $V_{w2} = 83775.804$
 - $s_2 = 150.00$
- Grid Shear Force, $V_{w3} = 0.00$
- Concrete Shear Force, $V_c = 125046.828$
- (The variables above have already been given in Shear control ratio calculation)
- Mean diameter of all bars, $d_b = 17.33333$
- Design Shear Force, $V = 4.8629285E-015$

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: rcrws

Constant Properties

Knowledge Factor, $\gamma = 0.85$

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

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

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = -5.9539400E-011$

Shear Force, $V_a = 4.8629285E-015$

EDGE -B-

Bending Moment, $M_b = 7.2444996E-011$

Shear Force, $V_b = -4.8629285E-015$

BOTH EDGES

Axial Force, $F = -29003.068$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 0.00$

-Compression: $A_{sc} = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

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

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

-Middle: $A_{st,mid} = 1608.495$

Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 17.20$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = V_n = 176728.571$
From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c^{0.5} \cdot h \cdot d = 207915.965$

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: $V_c = 124140.161$
 $\mu_u / \mu_l - l_w / 2 = 14772.401 > 0$

= 1 (normal-weight concrete)

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

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$\mu_u = 7.2444996E-011$

$V_u = 4.8629285E-015$

$N_u = 29003.068$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

$V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

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

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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:

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 400.00$

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

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

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

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

$b_w = 3000.00$

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

At local axis: 2

Integration Section: (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 (θ_u)

Edge: End

Local Axis: (2)



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

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcw

Constant Properties

Knowledge Factor, $\gamma = 0.85$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

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

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

#####

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, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = -6.3108872E-029$

EDGE -B-

Shear Force, $V_b = 6.3108872E-029$

BOTH EDGES

Axial Force, $F = -27514.027$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 0.00$

-Compression: $As_c = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 2865.133$

-Compression: $As_{l,com} = 2865.133$

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

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

Calculation of Shear Capacity ratio, $V_e/V_r = 2.43595$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 4.0910E+006$

with

$M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 6.1366E+009$

$Mu_{1+} = 5.5677E+009$, 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

$Mu_{1-} = 6.1366E+009$, 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

$M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 6.1366E+009$

$Mu_{2+} = 5.5677E+009$, 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

$Mu_{2-} = 6.1366E+009$, 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:

$\phi_u = 1.1598028E-005$

$M_u = 5.5677E+009$

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$

$v = 0.00186094$

$N = 27514.027$

$f_c = 20.00$

α_1 (5A.5, TBDY) = 0.002

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

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

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

ϕ_{we} (5.4c) = 0.00

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

$\phi_{ase1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi_{2,1} = 655400.00$

$\phi_{ase2} = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi_{2,2} = 655400.00$

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

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

Expression ((5.4d), TBDY) for $\phi_{psh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without

earthquake detailing (90° closed stirrups)

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 = 555.55

fce = 20.00

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

c = confinement factor = 1.00

y1 = 0.00231479

sh1 = 0.008

ft1 = 666.66

fy1 = 555.55

su1 = 0.032

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

lo/lou,min = lb/lb = 1.00

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

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

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

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

with fs1 = fs = 555.55

with Es1 = Es = 200000.00

y2 = 0.00231479

sh2 = 0.008

ft2 = 666.66

fy2 = 555.55

su2 = 0.032

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

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

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

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

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

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

with $fs_2 = fs = 555.55$

with $Es_2 = Es = 200000.00$

$yv = 0.00231479$

$shv = 0.008$

$ftv = 666.66$

$fyv = 555.55$

$suv = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$lo/lou, \text{min} = lb/d = 1.00$

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

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

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

For calculation of $esuv_{\text{nominal}}$ and yv, shv, ftv, fyv , it is considered

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

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

with $fsv = fs = 555.55$

with $Esv = Es = 200000.00$

1 = $Asl, \text{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.10765806$

2 = $Asl, \text{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.10765806$

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

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 = $Asl, \text{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.14310722$

2 = $Asl, \text{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.14310722$

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

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < vs, y_2$ - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.06692943

$Mu = MRc$ (4.14) = 5.5677E+009

$u = su$ (4.1) = 1.1598028E-005

Calculation of ratio lb/d

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

Calculation of Mu_1 -

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

$u = 1.1691922E-005$

$Mu = 6.1366E+009$

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

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) = $(ase1 \cdot Acol1 + ase2 \cdot Acol2 + ase3 \cdot Aweb) / Asec = 0.00$

$ase1 = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$ase2 = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$ase3 = 0$ (grid does not provide confinement)

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

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

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

$h1 = 600.00$

$As1 = Astir1 \cdot ns1 = 157.0796$

No stirrups, $ns1 = 2.00$

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

$h2 = 600.00$

$As2 = Astir2 \cdot ns2 = 157.0796$

No stirrups, $ns2 = 2.00$

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

$h3 = 1800.00$

$As3 = Astir3 \cdot ns3 = 0.00$

No stirrups, $ns3 = 2.00$

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

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

$h1 = 250.00$

$As1 = Astir1 \cdot ns1 = 157.0796$

No stirrups, $ns1 = 2.00$

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

$h2 = 250.00$

$As2 = Astir2 \cdot ns2 = 157.0796$

No stirrups, $ns2 = 2.00$

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

$h3 = 250.00$

$As3 = Astir3 \cdot ns3 = 157.0796$

No stirrups, $ns3 = 0.00$

$Asec = 750000.00$

$s_1 = 150.00$

$s_2 = 150.00$

$s_3 = 200.00$

$fywe = 555.55$

$fce = 20.00$

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

$c =$ confinement factor = 1.00

$y1 = 0.00231479$

$sh1 = 0.008$

$ft1 = 666.66$

$fy1 = 555.55$

$su1 = 0.032$

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

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

$su1 = 0.4 \cdot esu1_nominal$ ((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.

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

with $fs_1 = fs = 555.55$

with $Es_1 = Es = 200000.00$

$y_2 = 0.00231479$

$sh_2 = 0.008$

$ft_2 = 666.66$

$fy_2 = 555.55$

$su_2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

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

$su_2 = 0.4 \cdot esu_2, nominal ((5.5), TBDY) = 0.032$

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

with $fs_2 = fs = 555.55$

with $Es_2 = Es = 200000.00$

$y_v = 0.00231479$

$sh_v = 0.008$

$ft_v = 666.66$

$fy_v = 555.55$

$su_v = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

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

$su_v = 0.4 \cdot esuv, nominal ((5.5), TBDY) = 0.032$

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

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

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

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

with $fsv = fs = 555.55$

with $Esv = Es = 200000.00$

$1 = Asl, ten / (b \cdot d) \cdot (fs_1 / fc) = 0.10765806$

$2 = Asl, com / (b \cdot d) \cdot (fs_2 / fc) = 0.10765806$

$v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.02313704$

and confined core properties:

$b = 190.00$

$d = 2927.00$

$d' = 13.00$

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

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

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

$1 = Asl, ten / (b \cdot d) \cdot (fs_1 / fc) = 0.14310722$

$2 = Asl, com / (b \cdot d) \cdot (fs_2 / fc) = 0.14310722$

$v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.0307555$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

$v < v_{s, y_2}$ - LHS eq.(4.5) is satisfied

$su (4.9) = 0.07442258$

$Mu = MRc (4.14) = 6.1366E+009$

$u = su (4.1) = 1.1691922E-005$

Calculation of ratio lb/d

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

Calculation of Mu_{2+}

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

$$u = 1.1598028E-005$$

$$\mu = 5.5677E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00186094$$

$$N = 27514.027$$

$$f_c = 20.00$$

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

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

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

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

$$w_e(5.4c) = 0.00$$

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

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

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

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

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

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

$$h_1 = 600.00$$

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

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

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

$$h_2 = 600.00$$

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

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

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

$$h_3 = 1800.00$$

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

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

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

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

$$h_1 = 250.00$$

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

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

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

$$h_2 = 250.00$$

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

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

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

$$h_3 = 250.00$$

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

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

$$A_{sec} = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 555.55$$

fce = 20.00

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

c = confinement factor = 1.00

y1 = 0.00231479

sh1 = 0.008

ft1 = 666.66

fy1 = 555.55

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

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

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

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

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

with fs1 = fs = 555.55

with Es1 = Es = 200000.00

y2 = 0.00231479

sh2 = 0.008

ft2 = 666.66

fy2 = 555.55

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

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

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

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

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

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

with fs2 = fs = 555.55

with Es2 = Es = 200000.00

yv = 0.00231479

shv = 0.008

ftv = 666.66

fyv = 555.55

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

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

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

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

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

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

with fsv = fs = 555.55

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.10765806

2 = Asl,com/(b*d)*(fs2/fc) = 0.10765806

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) = 0.14310722

2 = Asl,com/(b*d)*(fs2/fc) = 0.14310722

v = Asl,mid/(b*d)*(fsv/fc) = 0.00

Case/Assumption: Unconfinedsd full section - Steel rupture

' satisfies Eq. (4.3)

--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.06692943
Mu = MRc (4.14) = 5.5677E+009
u = su (4.1) = 1.1598028E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.1691922E-005
Mu = 6.1366E+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
Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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 = 555.55
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00231479
sh1 = 0.008
ft1 = 666.66
fy1 = 555.55
su1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 555.55
with Es1 = Es = 200000.00
y2 = 0.00231479
sh2 = 0.008
ft2 = 666.66
fy2 = 555.55
su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 555.55
with Es2 = Es = 200000.00
yv = 0.00231479
shv = 0.008
ftv = 666.66
fyv = 555.55
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 555.55

with $E_{sv} = E_s = 200000.00$

$$1 = A_{s1,ten}/(b*d)*(f_{s1}/f_c) = 0.10765806$$

$$2 = A_{s1,com}/(b*d)*(f_{s2}/f_c) = 0.10765806$$

$$v = A_{s1,mid}/(b*d)*(f_{sv}/f_c) = 0.02313704$$

and confined core properties:

$$b = 190.00$$

$$d = 2927.00$$

$$d' = 13.00$$

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

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

c = confinement factor = 1.00

$$1 = A_{s1,ten}/(b*d)*(f_{s1}/f_c) = 0.14310722$$

$$2 = A_{s1,com}/(b*d)*(f_{s2}/f_c) = 0.14310722$$

$$v = A_{s1,mid}/(b*d)*(f_{sv}/f_c) = 0.0307555$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$s_u (4.9) = 0.07442258$$

$$M_u = M_{Rc} (4.14) = 6.1366E+009$$

$$u = s_u (4.1) = 1.1691922E-005$$

Calculation of ratio l_b/d

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

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 1.6794E+006$

Calculation of Shear Strength at edge 1, $V_{r1} = 1.6794E+006$

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)

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

$$h = 250.00$$

$$d = 2400.00$$

$$l_w = 3000.00$$

$$M_u = 3.2196245E-010$$

$$V_u = 6.3108872E-029$$

$$N_u = 27514.027$$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 949449.618$

$V_{s1} = 223399.91$ is calculated for pseudo-Column 1, with:

$$d = 480.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 444.44$$

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

$V_{s2} = 223399.91$ is calculated for pseudo-Column 2, with:

$$d = 480.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 444.44$$

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

$V_{s3} = 502649.798$ is calculated for web, with:

$$d = 1440.00$$

$$A_v = 157079.633$$

$$s = 200.00$$

$$f_y = 444.44$$

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 = 1.6794E+006
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 = 250.00
d = 2400.00
lw = 3000.00
Mu = 3.2196245E-010
Vu = 6.3108872E-029
Nu = 27514.027

From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 + Vs3 = 949449.618
Vs1 = 223399.91 is calculated for pseudo-Column 1, with:

d = 480.00
Av = 157079.633
s = 150.00
fy = 444.44

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

Vs2 = 223399.91 is calculated for pseudo-Column 2, with:

d = 480.00
Av = 157079.633
s = 150.00
fy = 444.44

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

Vs3 = 502649.798 is calculated for web, with:

d = 1440.00
Av = 157079.633
s = 200.00
fy = 444.44

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: rcwrs

Constant Properties

Knowledge Factor, = 0.85
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 16.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

#####

Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

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

#####

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = 0.00$

EDGE -B-

Shear Force, $V_b = 0.00$

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 , $V_e/V_r = 0.28750647$

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

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

with

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

$M_{u1+} = 2.4327E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$M_{u1-} = 3.1796E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

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

$M_{u2+} = 2.4327E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

$M_{u2-} = 3.1796E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

Calculation of M_{u1+}

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

$\phi_u = 0.00019144$

$M_u = 2.4327E+008$

with full section properties:

$b = 3000.00$

$d = 208.00$

$d' = 42.00$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

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

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

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

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

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

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

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

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

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

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

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

$$h_1 = 600.00$$

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

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

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

$$h_2 = 600.00$$

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

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

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

$$h_3 = 1800.00$$

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

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

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

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

$$h_1 = 250.00$$

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

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

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

$$h_2 = 250.00$$

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

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

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

$$h_3 = 250.00$$

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

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

$$A_{sec} = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 500.00$$

$$f_{ce} = 16.00$$

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

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

$$y_1 = 0.00208333$$

$$sh_1 = 0.00805$$

$$ft_1 = 600.00$$

$$fy_1 = 500.00$$

$$su_1 = 0.03226667$$

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

Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

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

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

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

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

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

y2 = 0.00208333

sh2 = 0.00805

ft2 = 600.00

fy2 = 500.00

su2 = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

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

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

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

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

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

with fs2 = fs = 500.00

with Es2 = Es = 200000.00

yv = 0.00208333

shv = 0.00805

ftv = 600.00

fyv = 500.00

suv = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

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

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

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

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

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

with fsv = fs = 500.00

with Esv = Es = 200000.00

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

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

v = Asl,mid/(b*d)*(fsv/fc) = 0.00

and confined core properties:

b = 2940.00

d = 178.00

d' = 12.00

fcc (5A.2, TBDY) = 16.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031

2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031

v = Asl,mid/(b*d)*(fsv/fc) = 0.00

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

v < vs,c - RHS eq.(4.5) is satisfied

--->

su (4.9) = 0.18965884

Mu = MRc (4.14) = 2.4327E+008

u = su (4.1) = 0.00019144

Calculation of ratio lb/d

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

Calculation of μ_1 -

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

$$\mu = 0.00019712$$

$$\mu_1 = 3.1796E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

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

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

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

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

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

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi_{2,1} = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi_{2,2} = 655400.00$$

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

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

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

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

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

$$h_1 = 600.00$$

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

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

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

$$h_2 = 600.00$$

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

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

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

$$h_3 = 1800.00$$

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

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

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

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

$$h_1 = 250.00$$

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

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

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

$$h_2 = 250.00$$

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

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

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

$$h_3 = 250.00$$

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

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

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 500.00
fce = 16.00
From ((5.A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00208333
sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with fsv = fs = 500.00
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785
2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785
v = Asl,mid/(b*d)*(fsv/fc) = 0.08055366
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = $As_{l,ten}/(b*d)*(f_s1/f_c) = 0.14145031$

2 = $As_{l,com}/(b*d)*(f_s2/f_c) = 0.14145031$

v = $As_{l,mid}/(b*d)*(f_{sv}/f_c) = 0.09605114$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

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

---->

su (4.9) = 0.2130262

Mu = MRc (4.14) = 3.1796E+008

u = su (4.1) = 0.00019712

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

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

u = 0.00019144

Mu = 2.4327E+008

with full section properties:

b = 3000.00

d = 208.00

d' = 42.00

v = 0.00275581

N = 27514.027

fc = 16.00

co (5A.5, TBDY) = 0.002

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

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

From (5.4b), TBDY: cu = 0.0035

we (5.4c) = 0.00

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

ase1 = 0.00

sh_1 = 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

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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 stirrups, ns1 = 2.00

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

h2 = 600.00

As2 = Astir2*ns2 = 157.0796

No stirrups, 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 = 500.00
fce = 16.00

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

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

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

lo/lou,min = lb/lb = 1.00

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

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

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

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

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

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

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

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

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

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

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

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

with fs2 = fs = 500.00

with Es2 = Es = 200000.00

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

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

lo/lou,min = lb/lb = 1.00

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

From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
 considering characteristic value $fsv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv,ftv,fyv , it is considered
 characteristic value $fsv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 500.00$
 with $Esv = Es = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00$

and confined core properties:

$b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 fcc (5A.2, TBDY) = 16.00
 cc (5A.5, TBDY) = 0.002
 $c =$ confinement factor = 1.00
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00$

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

---->
 $v < vs,c$ - RHS eq.(4.5) is satisfied

---->
 su (4.9) = 0.18965884
 $Mu = MRc$ (4.14) = 2.4327E+008
 $u = su$ (4.1) = 0.00019144

 Calculation of ratio lb/d

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

 Calculation of $Mu2$ -

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

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

 with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $fc = 16.00$
 co (5A.5, TBDY) = 0.002
 Final value of cu : $cu^* = shear_factor * Max(cu, cc) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0035$
 we (5.4c) = 0.00
 ase ((5.4d), TBDY) = $(ase1*Acol1+ase2*Acol2+ase3*Aweb)/Asec = 0.00$
 $ase1 = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $ase2 = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$

ase3 = 0 (grid does not provide confinement)
psh,min = Min(psh,x , psh,y) = 0.00069813
Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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 = 500.00
fce = 16.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00208333
sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667

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

lo/lou,min = lb/lb = 1.00

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

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

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

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

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

y2 = 0.00208333

sh2 = 0.00805

ft2 = 600.00

fy2 = 500.00

su2 = 0.03226667

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

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

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

From table 5A.1, TBDY: $es_{u2_nominal} = 0.08066667$,
For calculation of $es_{u2_nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $fs_{y2} = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs_2 = fs = 500.00$
with $Es_2 = Es = 200000.00$

$$y_v = 0.00208333$$

$$sh_v = 0.00805$$

$$ft_v = 600.00$$

$$fy_v = 500.00$$

$$suv = 0.03226667$$

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

$$lo/lo_{u,min} = lb/d = 1.00$$

$$suv = 0.4 \cdot es_{u_nominal} ((5.5), TBDY) = 0.03226667$$

From table 5A.1, TBDY: $es_{uv_nominal} = 0.08066667$,

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

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

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

with $fs_v = fs = 500.00$

with $Es_v = Es = 200000.00$

$$1 = As_{l,ten}/(b \cdot d) \cdot (fs_1/fc) = 0.11862785$$

$$2 = As_{l,com}/(b \cdot d) \cdot (fs_2/fc) = 0.11862785$$

$$v = As_{l,mid}/(b \cdot d) \cdot (fs_v/fc) = 0.08055366$$

and confined core properties:

$$b = 2940.00$$

$$d = 178.00$$

$$d' = 12.00$$

$$fcc (5A.2, TBDY) = 16.00$$

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

c = confinement factor = 1.00

$$1 = As_{l,ten}/(b \cdot d) \cdot (fs_1/fc) = 0.14145031$$

$$2 = As_{l,com}/(b \cdot d) \cdot (fs_2/fc) = 0.14145031$$

$$v = As_{l,mid}/(b \cdot d) \cdot (fs_v/fc) = 0.09605114$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

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

--->

$$su (4.9) = 0.2130262$$

$$Mu = MRc (4.14) = 3.1796E+008$$

$$u = su (4.1) = 0.00019712$$

Calculation of ratio lb/d

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

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 737278.61$

Calculation of Shear Strength at edge 1, $V_{r1} = 737278.61$

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

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

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

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

= 1 (normal-weight concrete)

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

$$h = 3000.00$$

$$d = 200.00$$

lw = 250.00
Mu = 1.4551920E-011
Vu = 0.00
Nu = 27514.027

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

$V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

d = 200.00
Av = 157079.633
s = 150.00
fy = 400.00

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

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

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

d = 200.00
Av = 157079.633
s = 150.00
fy = 400.00

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
Av = 0.00
s = 200.00
fy = 400.00

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

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

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

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

bw = 3000.00

Calculation of Shear Strength at edge 2, $V_{r2} = 737278.61$

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

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

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

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

= 1 (normal-weight concrete)

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

h = 3000.00

d = 200.00

lw = 250.00

Mu = 1.4551920E-011

Vu = 0.00

Nu = 27514.027

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

$V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

d = 200.00
Av = 157079.633
s = 150.00
fy = 400.00

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

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

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

d = 200.00
Av = 157079.633
s = 150.00
fy = 400.00

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
Av = 0.00
s = 200.00
fy = 400.00

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

$2(1-s/d) = 0.00$
 $V_f((11-3)-(11.4), ACI 440) = 0.00$
From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$
 $bw = 3000.00$

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

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

Constant Properties

Knowledge Factor, $\phi = 0.85$
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 $n = ps_1 + ps_2 + ps_3$, being the shear reinf. ratio in a plane perpendicular to the shear axis 3
(pseudo-col.1 $ps_1 = A_{s1} * b_1 / s_1 = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$
 $h_1 = 250.00$
 $s_1 = 150.00$
total area of hoops perpendicular to shear axis, $A_{s1} = 157.0796$
(pseudo-col.2 $ps_2 = A_{s2} * b_2 / s_2 = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$
 $h_2 = 250.00$
 $s_2 = 150.00$
total area of hoops perpendicular to shear axis, $A_{s2} = 157.0796$
(grid $ps_3 = A_{s3} * b_3 / s_3 = (A_{s3} * h_3 / s_3) / A_c = 0.00$
 $h_3 = 250.00$
 $s_3 = 200.00$
total area of hoops perpendicular to shear axis, $A_{s3} = 0.00$
total section area, $A_c = 750000.00$

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$
Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$
Concrete Elasticity, $E_c = 21019.039$
Steel Elasticity, $E_s = 200000.00$
Total Height, $H_{tot} = 3000.00$
Edges Width, $W_{edg} = 250.00$
Edges Height, $H_{edg} = 600.00$
Web Width, $W_{web} = 250.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_b/d \geq 1$)
No FRP Wrapping

Stepwise Properties

Axial Force, $F = -29003.068$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl} = 0.00$
-Compression: $A_{slc} = 6346.017$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten} = 2865.133$

-Compression: $As_{l,com} = 2865.133$

-Middle: $As_{l,mid} = 615.7522$

Mean Diameter of Tension Reinforcement, $DbL = 17.33333$

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

Existing component: From table 7-7, ASCE 41_17: Final interstorey drift Capacity $u_{i,R} = \mu \cdot u = 0.004$
from table 10-20: $u = 0.00470588$

with:

- Condition i (shear wall and wall segments)

- $(As - As') \cdot fy + P / (tw \cdot lw \cdot fc') = -0.20911698$

$As = 0.00$

$As' = 6346.017$

$fy = 400.00$

$P = 29003.068$

$tw = 250.00$

$lw = 3000.00$

$fc = 16.00$

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

At local axis: 2

Integration Section: (a)

Calculation No. 7

wall W1, Floor 1

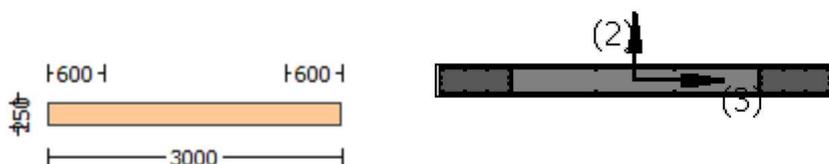
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)



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

At local axis: 3

Integration Section: (d)

Section Type: rcw

Constant Properties

Knowledge Factor, $\gamma = 0.85$

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

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

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

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

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 6.7641E+007$

Shear Force, $V_a = -22635.166$

EDGE -B-

Bending Moment, $M_b = 276085.688$

Shear Force, $V_b = 22635.166$

BOTH EDGES

Axial Force, $F = -29003.068$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

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

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

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten} = 2865.133$

-Compression: $A_{sl,com} = 2865.133$

-Middle: $A_{sl,mid} = 615.7522$

Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 17.33333$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = \phi V_n = 1.2821E+006$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c^{0.5} \cdot h \cdot d = 1.5083E+006$

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw + ϕV_f '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (11.5.4.6(d-e)), ACI 318-14: $V_c = 653800.614$

$\mu_u / \mu_l - l_w / 2 = -1487.803 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$$\mu_u = 276085.688$$

$$V_u = 22635.166$$

$$N_u = 29003.068$$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$

$V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:

$$d = 480.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 400.00$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:

$$d = 480.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 400.00$$

V_{s2} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s3} = 452389.342$ is calculated for web, with:

$$d = 1440.00$$

$$A_v = 157079.633$$

$$s = 200.00$$

$$f_y = 400.00$$

V_{s3} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

V_f ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$

$$b_w = 250.00$$

End Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (d)

Calculation No. 8

wall W1, Floor 1

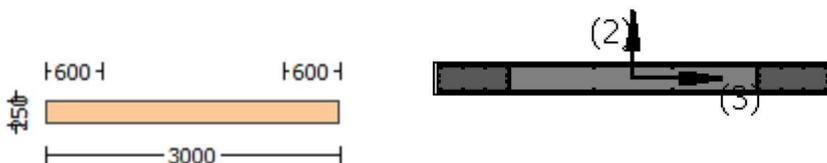
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcrcws

Constant Properties

Knowledge Factor, $\gamma = 0.85$
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$
Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$
Concrete Elasticity, $E_c = 21019.039$
Steel Elasticity, $E_s = 200000.00$

Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 555.55$

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, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_o/l_{ou, min} > 1$)
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, $V_a = -6.3108872E-029$
EDGE -B-
Shear Force, $V_b = 6.3108872E-029$
BOTH EDGES
Axial Force, $F = -27514.027$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl, t} = 0.00$
-Compression: $A_{sl, c} = 6346.017$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl, ten} = 2865.133$
-Compression: $A_{sl, com} = 2865.133$
-Middle: $A_{sl, mid} = 0.00$
(According to 10.7.2.3 $A_{sl, mid}$ is setted equal to zero)

Calculation of Shear Capacity ratio, $V_e/V_r = 2.43595$
Member Controlled by Shear ($V_e/V_r > 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 4.0910E+006$
with
 $M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 6.1366E+009$
 $M_{u1+} = 5.5677E+009$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
 $M_{u1-} = 6.1366E+009$, 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

$$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 6.1366E+009$$

$M_{u2+} = 5.5677E+009$, 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

$M_{u2-} = 6.1366E+009$, 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:

$$\phi_u = 1.1598028E-005$$

$$M_u = 5.5677E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00186094$$

$$N = 27514.027$$

$$f_c = 20.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0035$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.0035$$

$$w_e \text{ (5.4c)} = 0.00$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$$

$$p_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$p_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$p_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirrups, } n_{s3} = 2.00$$

$$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$$

$$p_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$p_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$p_{s3,y} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

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 = 555.55

fce = 20.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00231479

sh1 = 0.008

ft1 = 666.66

fy1 = 555.55

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 555.55

with Es1 = Es = 200000.00

y2 = 0.00231479

sh2 = 0.008

ft2 = 666.66

fy2 = 555.55

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 555.55

with Es2 = Es = 200000.00

yv = 0.00231479

shv = 0.008

ftv = 666.66

fyv = 555.55

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = fs = 555.55

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.10765806

2 = Asl,com/(b*d)*(fs2/fc) = 0.10765806

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) = 0.14310722
2 = Asl,com/(b*d)*(fs2/fc) = 0.14310722
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) = 0.06692943
Mu = MRc (4.14) = 5.5677E+009
u = su (4.1) = 1.1598028E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 1.1691922E-005
Mu = 6.1366E+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

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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) = $(As3 \cdot h3 / s_3) / Ac = 0.00188496$
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) = $(As1 \cdot h1 / s_1) / Ac = 0.00034907$
h1 = 250.00
As1 = Astir1 * 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 * ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,y (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00$
h3 = 250.00
As3 = Astir3 * ns3 = 157.0796
No stirups, ns3 = 0.00

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 555.55
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00231479
sh1 = 0.008
ft1 = 666.66
fy1 = 555.55
su1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su1 = 0.4 * esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1, ft1, fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1, ft1, fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.
with fs1 = fs = 555.55
with Es1 = Es = 200000.00
y2 = 0.00231479
sh2 = 0.008
ft2 = 666.66
fy2 = 555.55
su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4 * esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2, ft2, fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1, ft1, fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.
with fs2 = fs = 555.55
with Es2 = Es = 200000.00
yv = 0.00231479
shv = 0.008
ftv = 666.66
fyv = 555.55
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
 $l_0/l_{ou,min} = l_b/l_d = 1.00$
 $s_{uv} = 0.4 * e_{suv_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $e_{suv_nominal} = 0.08$,
 considering characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $e_{suv_nominal}$ and γ_v , sh_v, ft_v, fy_v , it is considered
 characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.
 $\gamma_1, sh_1, ft_1, fy_1$, are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = f_s = 555.55$
 with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b*d) * (f_{s1}/f_c) = 0.10765806$
 $2 = A_{sl,com}/(b*d) * (f_{s2}/f_c) = 0.10765806$
 $v = A_{sl,mid}/(b*d) * (f_{sv}/f_c) = 0.02313704$

and confined core properties:

$b = 190.00$
 $d = 2927.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 20.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d) * (f_{s1}/f_c) = 0.14310722$
 $2 = A_{sl,com}/(b*d) * (f_{s2}/f_c) = 0.14310722$
 $v = A_{sl,mid}/(b*d) * (f_{sv}/f_c) = 0.0307555$

Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $s_u (4.9) = 0.07442258$
 $M_u = M_{Rc} (4.14) = 6.1366E+009$
 $u = s_u (4.1) = 1.1691922E-005$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of M_{u2+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$u = 1.1598028E-005$
 $M_u = 5.5677E+009$

with full section properties:

$b = 250.00$
 $d = 2957.00$
 $d' = 43.00$
 $v = 0.00186094$
 $N = 27514.027$
 $f_c = 20.00$
 $cc (5A.5, TBDY) = 0.002$
 Final value of c_u : $c_u^* = \text{shear_factor} * \text{Max}(c_u, cc) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.0035$
 $w_e (5.4c) = 0.00$
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$
 $a_{se1} = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $a_{se2} = 0.00$
 $sh_2 = 150.00$

bo_2 = 190.00
ho_2 = 540.00
bi2_2 = 655400.00

ase3 = 0 (grid does not provide confinement)
psh,min = Min(psh,x , psh,y) = 0.00069813

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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 stirrups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776
h2 = 600.00
As2 = Astir2*ns2 = 157.0796
No stirrups, ns2 = 2.00
ps3,x (web) = (As3*h3/s_3)/Ac = 0.00188496
h3 = 1800.00
As3 = Astir3*ns3 = 0.00
No stirrups, 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 stirrups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
h2 = 250.00
As2 = Astir2*ns2 = 157.0796
No stirrups, ns2 = 2.00
ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
h3 = 250.00
As3 = Astir3*ns3 = 157.0796
No stirrups, ns3 = 0.00

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00

fywe = 555.55
fce = 20.00

From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00

y1 = 0.00231479

sh1 = 0.008

ft1 = 666.66

fy1 = 555.55

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^2/3), from 10.3.5, ASCE 41-17.

with fs1 = fs = 555.55

with Es1 = Es = 200000.00

y2 = 0.00231479

sh2 = 0.008

ft2 = 666.66

fy2 = 555.55

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 555.55

with Es2 = Es = 200000.00

yv = 0.00231479

shv = 0.008

ftv = 666.66

fyv = 555.55

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

lo/lou,min = lb/ld = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = fs = 555.55

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.10765806

2 = Asl,com/(b*d)*(fs2/fc) = 0.10765806

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) = 0.14310722

2 = Asl,com/(b*d)*(fs2/fc) = 0.14310722

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) = 0.06692943

Mu = MRc (4.14) = 5.5677E+009

u = su (4.1) = 1.1598028E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 1.1691922E-005

Mu = 6.1366E+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)

$$\text{From (5.4b), TBDY: } c_u = 0.0035$$

$$w_e (5.4c) = 0.00$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$$

$$p_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$p_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$p_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirrups, } n_{s3} = 2.00$$

$$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$$

$$p_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$p_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$p_{s3,y} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

$$\text{No stirrups, } n_{s3} = 0.00$$

$$A_{sec} = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 555.55$$

$$f_{ce} = 20.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.00231479$$

$$sh_1 = 0.008$$

$$ft_1 = 666.66$$

$$fy_1 = 555.55$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 555.55

with Es1 = Es = 200000.00

y2 = 0.00231479

sh2 = 0.008

ft2 = 666.66

fy2 = 555.55

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 555.55

with Es2 = Es = 200000.00

yv = 0.00231479

shv = 0.008

ftv = 666.66

fyv = 555.55

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = fs = 555.55

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.10765806

2 = Asl,com/(b*d)*(fs2/fc) = 0.10765806

v = Asl,mid/(b*d)*(fsv/fc) = 0.02313704

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) = 0.14310722

2 = Asl,com/(b*d)*(fs2/fc) = 0.14310722

v = Asl,mid/(b*d)*(fsv/fc) = 0.0307555

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

v < vs,y2 - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.07442258

Mu = MRc (4.14) = 6.1366E+009

u = su (4.1) = 1.1691922E-005

Calculation of ratio lb/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 1.6794\text{E}+006$

Calculation of Shear Strength at edge 1, $V_{r1} = 1.6794\text{E}+006$
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) '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: $V_c = 729988.83$

$\mu_u / \mu - l_w / 2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 3.2196245\text{E}-010$

$V_u = 6.3108872\text{E}-029$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 949449.618$

$V_{s1} = 223399.91$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 444.44$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 223399.91$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 444.44$

V_{s2} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s3} = 502649.798$ is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 444.44$

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: $V_s + V_f \leq 1.7825\text{E}+006$

$b_w = 250.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 1.6794\text{E}+006$

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) '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: $V_c = 729988.83$

$\mu_u / \mu - l_w / 2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 3.2196245\text{E}-010$

$V_u = 6.3108872\text{E}-029$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 949449.618$

$V_{s1} = 223399.91$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

fy = 444.44

Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs2 = 223399.91 is calculated for pseudo-Column 2, with:

d = 480.00

Av = 157079.633

s = 150.00

fy = 444.44

Vs2 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs3 = 502649.798 is calculated for web, with:

d = 1440.00

Av = 157079.633

s = 200.00

fy = 444.44

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

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, $\phi = 0.85$

Mean strength values are used for both shear and moment calculations.

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 500.00$

#####

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou, min} \geq 1$)

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = 0.00$

EDGE -B-

Shear Force, $V_b = 0.00$

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: $As_{,ten} = 2368.761$
-Compression: $As_{,com} = 2368.761$
-Middle: $As_{,mid} = 0.00$
(According to 10.7.2.3 $As_{,mid}$ is setted equal to zero)

Calculation of Shear Capacity ratio, $V_e/V_r = 0.28750647$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 211972.373$
with

$M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 3.1796E+008$
 $Mu_{1+} = 2.4327E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
 $Mu_{1-} = 3.1796E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 3.1796E+008$
 $Mu_{2+} = 2.4327E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
 $Mu_{2-} = 3.1796E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

Calculation of Mu_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 0.00019144$
 $M_u = 2.4327E+008$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $f_c = 16.00$
 $\alpha = (5A.5, \text{TBDY}) = 0.002$
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
 $\alpha_{se}((5.4d), \text{TBDY}) = (\alpha_{se1} * A_{col1} + \alpha_{se2} * A_{col2} + \alpha_{se3} * A_{web}) / A_{sec} = 0.00$
 $\alpha_{se1} = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi_{2,1} = 655400.00$
 $\alpha_{se2} = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi_{2,2} = 655400.00$
 $\alpha_{se3} = 0$ (grid does not provide confinement)
 $psh_{,min} = \text{Min}(psh_x, psh_y) = 0.00069813$
Expression ((5.4d), TBDY) for $psh_{,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh_x = ps_{1,x} + ps_{2,x} + ps_{3,x} = 0.00356047$
 $ps_{1,x} (\text{column 1}) = (As_1 * h_1 / s_1) / A_c = 0.00083776$

h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/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 = 500.00
fce = 16.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00208333
sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/l_d = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/l_d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/l_b,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/l_d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333

$shv = 0.00805$
 $ftv = 600.00$
 $fyv = 500.00$
 $suv = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/d = 1.00$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv , shv,ftv,fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 500.00$
 with $Esv = Es = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00$
 and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $fcc (5A.2, TBDY) = 16.00$
 $cc (5A.5, TBDY) = 0.002$
 $c =$ confinement factor $= 1.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00$
 Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)
 --->
 $v < vs,c$ - RHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.18965884$
 $Mu = MRc (4.14) = 2.4327E+008$
 $u = su (4.1) = 0.00019144$

 Calculation of ratio lb/d

Adequate Lap Length: $lb/d \geq 1$

 Calculation of $Mu1$ -

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 0.00019712$
 $Mu = 3.1796E+008$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $fc = 16.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = shear_factor * Max(cu, cc) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0035$
 $we (5.4c) = 0.00$
 $ase ((5.4d), TBDY) = (ase1*Acol1 + ase2*Acol2 + ase3*Aweb)/Asec = 0.00$
 $ase1 = 0.00$

sh_1 = 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

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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*ns1 = 157.0796

No stirrups, ns1 = 2.00

ps2,x (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00083776$

h2 = 600.00

As2 = Astir2*ns2 = 157.0796

No stirrups, ns2 = 2.00

ps3,x (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00188496$

h3 = 1800.00

As3 = Astir3*ns3 = 0.00

No stirrups, 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*ns1 = 157.0796

No stirrups, ns1 = 2.00

ps2,y (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00034907$

h2 = 250.00

As2 = Astir2*ns2 = 157.0796

No stirrups, ns2 = 2.00

ps3,y (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00$

h3 = 250.00

As3 = Astir3*ns3 = 157.0796

No stirrups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 500.00

fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00208333

sh1 = 0.00805

ft1 = 600.00

fy1 = 500.00

su1 = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

su1 = $0.4 \cdot esu1_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

y2 = 0.00208333

$sh_2 = 0.00805$
 $ft_2 = 600.00$
 $fy_2 = 500.00$
 $su_2 = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lo_{u,min} = lb/lb_{u,min} = 1.00$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08066667$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 500.00$
 with $Es_2 = Es = 200000.00$
 $yv = 0.00208333$
 $shv = 0.00805$
 $ftv = 600.00$
 $fyv = 500.00$
 $suv = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lo_{u,min} = lb/ld = 1.00$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08066667$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 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 $fsv = fs = 500.00$
 with $Esv = Es = 200000.00$
 $1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.11862785$
 $2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.11862785$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.08055366$
 and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 fcc (5A.2, TBDY) = 16.00
 cc (5A.5, TBDY) = 0.002
 $c =$ confinement factor = 1.00
 $1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.14145031$
 $2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.14145031$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.09605114$
 Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)
 --->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied
 --->
 su (4.9) = 0.2130262
 $Mu = MRc$ (4.14) = 3.1796E+008
 $u = su$ (4.1) = 0.00019712

 Calculation of ratio lb/ld

Adequate Lap Length: $lb/ld \geq 1$

 Calculation of Mu_{2+}

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 0.00019144$

Mu = 2.4327E+008

with full section properties:

b = 3000.00

d = 208.00

d' = 42.00

v = 0.00275581

N = 27514.027

fc = 16.00

co (5A.5, TBDY) = 0.002

Final value of cu: $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0035$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $cu = 0.0035$

we (5.4c) = 0.00

ase ((5.4d), TBDY) = $(ase1*Acol1+ase2*Acol2+ase3*Aweb)/Asec = 0.00$

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 = $\text{Min}(psh,x, psh,y) = 0.00069813$

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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 stirrups, ns1 = 2.00

ps2,x (column 2) = $(As2*h2/s_2)/Ac = 0.00083776$

h2 = 600.00

As2 = $Astir2*ns2 = 157.0796$

No stirrups, ns2 = 2.00

ps3,x (web) = $(As3*h3/s_3)/Ac = 0.00188496$

h3 = 1800.00

As3 = $Astir3*ns3 = 0.00$

No stirrups, 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 stirrups, ns1 = 2.00

ps2,y (column 2) = $(As2*h2/s_2)/Ac = 0.00034907$

h2 = 250.00

As2 = $Astir2*ns2 = 157.0796$

No stirrups, ns2 = 2.00

ps3,y (web) = $(As3*h3/s_3)/Ac = 0.00$

h3 = 250.00

As3 = $Astir3*ns3 = 157.0796$

No stirrups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 500.00

fce = 16.00

From ((5.A5), TBDY), TBDY: $cc = 0.002$

c = confinement factor = 1.00

y1 = 0.00208333

$sh1 = 0.00805$
 $ft1 = 600.00$
 $fy1 = 500.00$
 $su1 = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/l_d = 1.00$
 $su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,
 For calculation of $esu1_nominal$ and $y1, sh1,ft1,fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = fs = 500.00$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00208333$
 $sh2 = 0.00805$
 $ft2 = 600.00$
 $fy2 = 500.00$
 $su2 = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/l_b,min = 1.00$
 $su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esu2_nominal = 0.08066667$,
 For calculation of $esu2_nominal$ and $y2, sh2,ft2,fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = fs = 500.00$
 with $Es2 = Es = 200000.00$
 $yv = 0.00208333$
 $shv = 0.00805$
 $ftv = 600.00$
 $fyv = 500.00$
 $suv = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/l_d = 1.00$
 $suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
 considering characteristic value $fsyv = fsv/1.2$, 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 $Min(1,1.25*(lb/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 500.00$
 with $Esv = Es = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00$
 and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $fcc (5A.2, TBDY) = 16.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00$
 Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)
 --->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.18965884$

$$\begin{aligned} \text{Mu} &= \text{MRc} (4.14) = 2.4327\text{E}+008 \\ u &= \text{su} (4.1) = 0.00019144 \end{aligned}$$

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 0.00019712$
 $\text{Mu} = 3.1796\text{E}+008$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $f_c = 16.00$
 $\text{co} (5A.5, \text{TBDY}) = 0.002$
Final value of cu : $\text{cu}^* = \text{shear_factor} * \text{Max}(\text{cu}, \text{cc}) = 0.0035$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\text{cu} = 0.0035$
we (5.4c) = 0.00
 $\text{ase} ((5.4d), \text{TBDY}) = (\text{ase1} * \text{Acol1} + \text{ase2} * \text{Acol2} + \text{ase3} * \text{Aweb}) / \text{Asec} = 0.00$
 $\text{ase1} = 0.00$
 $\text{sh}_1 = 150.00$
 $\text{bo}_1 = 190.00$
 $\text{ho}_1 = 540.00$
 $\text{bi2}_1 = 655400.00$
 $\text{ase2} = 0.00$
 $\text{sh}_2 = 150.00$
 $\text{bo}_2 = 190.00$
 $\text{ho}_2 = 540.00$
 $\text{bi2}_2 = 655400.00$
 $\text{ase3} = 0$ (grid does not provide confinement)
 $\text{psh,min} = \text{Min}(\text{psh,x}, \text{psh,y}) = 0.00069813$
Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$\text{psh,x} = \text{ps1,x} + \text{ps2,x} + \text{ps3,x} = 0.00356047$
 $\text{ps1,x} (\text{column 1}) = (\text{As1} * \text{h1} / \text{s}_1) / \text{Ac} = 0.00083776$
 $\text{h1} = 600.00$
 $\text{As1} = \text{Astir1} * \text{ns1} = 157.0796$
No stirrups, ns1 = 2.00
 $\text{ps2,x} (\text{column 2}) = (\text{As2} * \text{h2} / \text{s}_2) / \text{Ac} = 0.00083776$
 $\text{h2} = 600.00$
 $\text{As2} = \text{Astir2} * \text{ns2} = 157.0796$
No stirrups, ns2 = 2.00
 $\text{ps3,x} (\text{web}) = (\text{As3} * \text{h3} / \text{s}_3) / \text{Ac} = 0.00188496$
 $\text{h3} = 1800.00$
 $\text{As3} = \text{Astir3} * \text{ns3} = 0.00$
No stirrups, ns3 = 2.00

$\text{psh,y} = \text{ps1,y} + \text{ps2,y} + \text{ps3,y} = 0.00069813$
 $\text{ps1,y} (\text{column 1}) = (\text{As1} * \text{h1} / \text{s}_1) / \text{Ac} = 0.00034907$
 $\text{h1} = 250.00$
 $\text{As1} = \text{Astir1} * \text{ns1} = 157.0796$
No stirrups, ns1 = 2.00
 $\text{ps2,y} (\text{column 2}) = (\text{As2} * \text{h2} / \text{s}_2) / \text{Ac} = 0.00034907$
 $\text{h2} = 250.00$

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 = 500.00

fce = 16.00

From ((5.A.5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00208333

sh1 = 0.00805

ft1 = 600.00

fy1 = 500.00

su1 = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

y2 = 0.00208333

sh2 = 0.00805

ft2 = 600.00

fy2 = 500.00

su2 = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.

with fs2 = fs = 500.00

with Es2 = Es = 200000.00

yv = 0.00208333

shv = 0.00805

ftv = 600.00

fyv = 500.00

suv = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esuv_nominal = 0.08066667,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.

with fsv = fs = 500.00

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785

2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785

v = Asl,mid/(b*d)*(fsv/fc) = 0.08055366

and confined core properties:

$$b = 2940.00$$

$$d = 178.00$$

$$d' = 12.00$$

$$f_{cc} (5A.2, TBDY) = 16.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.14145031$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.14145031$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.09605114$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.2130262$$

$$\mu_u = M_{Rc} (4.14) = 3.1796E+008$$

$$u = s_u (4.1) = 0.00019712$$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 737278.61$

Calculation of Shear Strength at edge 1, $V_{r1} = 737278.61$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r1} = V_n < 0.83*f_c'^{0.5}*h*d$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f*V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$$\mu_u/V_u - l_w/2 = 0.00 \leq 0$$

= 1 (normal-weight concrete)

$$f_c' = 16.00, \text{ but } f_c'^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$h = 3000.00$$

$$d = 200.00$$

$$l_w = 250.00$$

$$\mu_u = 1.4551920E-011$$

$$V_u = 0.00$$

$$N_u = 27514.027$$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

$V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 400.00$$

V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 400.00$$

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:

$$d = 200.00$$

$$A_v = 0.00$$

$$s = 200.00$$

$$f_y = 400.00$$

V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.00$$

Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$
bw = 3000.00

Calculation of Shear Strength at edge 2, Vr2 = 737278.61
From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_r2 = V_n < 0.83*fc'^{0.5}*h*d$

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: Vc = 653502.805
 $\mu_u/\mu_u-lw/2 = 0.00 \leq 0$

= 1 (normal-weight concrete)
fc' = 16.00, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

h = 3000.00

d = 200.00

lw = 250.00

$\mu_u = 1.4551920E-011$

Vu = 0.00

Nu = 27514.027

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

Vs1 = 41887.902 is calculated for pseudo-Column 1, with:

d = 200.00

Av = 157079.633

s = 150.00

fy = 400.00

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 = 41887.902 is calculated for pseudo-Column 2, with:

d = 200.00

Av = 157079.633

s = 150.00

fy = 400.00

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 = 400.00

Vs3 has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$

bw = 3000.00

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1
At local axis: 3

Integration Section: (d)

Section Type: rcrws

Constant Properties

Knowledge Factor, $\eta = 0.85$

According to 10.7.2.3, ASCE 41-17, shear walls with

transverse reinforcement percentage, $\eta < 0.0015$

are considered Force-Controlled and lower-bound strengths are used according to 7.5.1.3, ASCE 41-17

$\eta = 0.00069813$

with $\eta = \rho_{s1} + \rho_{s2} + \rho_{s3}$, being the shear reinf. ratio in a plane perpendicular to the shear axis 2

(pseudo-col.1 $\rho_{s1} = A_{s1}*b_1/s_1 = (A_{s1}*h_1/s_1) / A_c = 0.00034907$

$h1 = 250.00$
 $s1 = 150.00$
 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:

Existing material of Secondary Member: Concrete Strength, $fc = fc_lower_bound = 16.00$
 Existing material of Secondary Member: Steel Strength, $fs = fs_lower_bound = 400.00$
 Concrete Elasticity, $Ec = 21019.039$
 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, $L = 3000.00$
 Secondary Member
 Smooth Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Adequate Lap Length ($lb/ld >= 1$)
 No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 7.2444996E-011$
 Shear Force, $V2 = -4.8629285E-015$
 Shear Force, $V3 = 22635.166$
 Axial Force, $F = -29003.068$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $Aslt = 0.00$
 -Compression: $Aslc = 6346.017$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $Asl,ten = 2368.761$
 -Compression: $Asl,com = 2368.761$
 -Middle: $Asl,mid = 1608.495$
 Mean Diameter of Tension Reinforcement, $DbL = 17.20$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u,R = * u = 0.0032804$
 $u = y + p = 0.00385929$

- Calculation of y -

$y = (My*Ip)/(EI)Eff = 0.00185929 ((10-5), ASCE 41-17))$
 $My = 2.2263E+008$
 $(EI)Eff = 0.35*Ec*I (table 10-5)$
 $Ec*I = 8.2106E+013$
 $Ip = 0.5*d = 0.5*(0.8*h) = 240.00$

Calculation of Yielding Moment My

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{\text{ten}}, y_{\text{com}})$
 $y_{\text{ten}} = 1.2994376\text{E-}005$
with $f_y = 400.00$
 $d = 208.00$
 $y = 0.26003492$
 $A = 0.0102861$
 $B = 0.00622792$
with $p_t = 0.00379609$
 $p_c = 0.00379609$
 $p_v = 0.00257772$
 $N = 29003.068$
 $b = 3000.00$
 $\mu = 0.20192308$
 $y_{\text{comp}} = 2.5442826\text{E-}005$
with $f_c = 16.00$
 $E_c = 21019.039$
 $y = 0.25891127$
 $A = 0.01000029$
 $B = 0.00611172$
with $E_s = 200000.00$

Calculation of ratio I_b/I_d

Adequate Lap Length: $I_b/I_d \geq 1$

- Calculation of ρ -

Considering wall controlled by flexure (shear control ratio ≤ 1),
from table 10-19: $\rho = 0.002$

with:

- Condition i (shear wall and wall segments)

- $(A_s - A_s') \cdot f_y + P / (t_w \cdot l_w \cdot f_c') = -0.20911698$

$A_s = 0.00$

$A_s' = 6346.017$

$f_y = 400.00$

$P = 29003.068$

$t_w = 3000.00$

$l_w = 250.00$

$f_c = 16.00$

- $V / (t_w \cdot l_w \cdot f_c^{0.5}) = 1.9520901\text{E-}020$, 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:

$V_{w1} = 83775.804$

$s_1 = 150.00$

Boundary Element 2:

$V_{w2} = 83775.804$

$s_2 = 150.00$

Grid Shear Force, $V_{w3} = 0.00$

Concrete Shear Force, $V_c = 124140.161$

(The variables above have already been given in Shear control ratio calculation)

Mean diameter of all bars, $d_b = 17.33333$

Design Shear Force, $V = 4.8629285\text{E-}015$

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: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcrcws

Constant Properties

Knowledge Factor, $\gamma = 0.85$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou,min} = l_b/l_d \geq 1$)

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = -9.8133593E-011$

Shear Force, $V_a = 7.3960296E-015$

EDGE -B-

Bending Moment, $M_b = 1.1776172E-010$

Shear Force, $V_b = -7.3960296E-015$

BOTH EDGES

Axial Force, $F = -29778.709$

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, $Db_{L,ten} = 17.20$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = V_n = 177166.736$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c^{0.5} \cdot h \cdot d = 208431.455$

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: $V_c = 124655.651$

$\mu_u / \nu_u - l_w / 2 = 13143.415 > 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$\mu_u = 9.8133593E-011$

$\nu_u = 7.3960296E-015$

$N_u = 29778.709$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

$V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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:

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 400.00$

V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

V_f ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$

$b_w = 3000.00$

End Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 2
Integration Section: (a)

Calculation No. 10

wall W1, Floor 1

Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (θ)

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: rcw

Constant Properties

Knowledge Factor, $\gamma = 0.85$

Mean strength values are used for both shear and moment calculations.

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 555.55$

#####

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
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_o/l_{ou}, \min >= 1$)
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, $V_a = -6.3108872E-029$
EDGE -B-
Shear Force, $V_b = 6.3108872E-029$
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, $V_e/V_r = 2.43595$
Member Controlled by Shear ($V_e/V_r > 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 4.0910E+006$
with
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 6.1366E+009$
 $Mu_{1+} = 5.5677E+009$, 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
 $Mu_{1-} = 6.1366E+009$, 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
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 6.1366E+009$
 $Mu_{2+} = 5.5677E+009$, 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
 $Mu_{2-} = 6.1366E+009$, 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:
 $\phi_u = 1.1598028E-005$
 $M_u = 5.5677E+009$

with full section properties:

$b = 250.00$
 $d = 2957.00$
 $d' = 43.00$
 $v = 0.00186094$
 $N = 27514.027$
 $f_c = 20.00$
 ϕ_o (5A.5, TBDY) = 0.002
Final value of ϕ_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)
From (5.4b), TBDY: $\phi_u = 0.0035$
we (5.4c) = 0.00

$$ase((5.4d), TBDY) = (ase1 * Acol1 + ase2 * Acol2 + ase3 * Aweb) / Asec = 0.00$$

$$ase1 = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$ase2 = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$ase3 = 0 \text{ (grid does not provide confinement)}$$

$$psh,min = \text{Min}(psh,x, psh,y) = 0.00069813$$

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$$

$$ps1,x \text{ (column 1)} = (As1 * h1 / s_1) / Ac = 0.00083776$$

$$h1 = 600.00$$

$$As1 = Astir1 * ns1 = 157.0796$$

No stirrups, ns1 = 2.00

$$ps2,x \text{ (column 2)} = (As2 * h2 / s_2) / Ac = 0.00083776$$

$$h2 = 600.00$$

$$As2 = Astir2 * ns2 = 157.0796$$

No stirrups, ns2 = 2.00

$$ps3,x \text{ (web)} = (As3 * h3 / s_3) / Ac = 0.00188496$$

$$h3 = 1800.00$$

$$As3 = Astir3 * ns3 = 0.00$$

No stirrups, 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 stirrups, ns1 = 2.00

$$ps2,y \text{ (column 2)} = (As2 * h2 / s_2) / Ac = 0.00034907$$

$$h2 = 250.00$$

$$As2 = Astir2 * ns2 = 157.0796$$

No stirrups, ns2 = 2.00

$$ps3,y \text{ (web)} = (As3 * h3 / s_3) / Ac = 0.00$$

$$h3 = 250.00$$

$$As3 = Astir3 * ns3 = 157.0796$$

No stirrups, ns3 = 0.00

$$Asec = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$fywe = 555.55$$

$$fce = 20.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.00231479$$

$$sh1 = 0.008$$

$$ft1 = 666.66$$

$$fy1 = 555.55$$

$$su1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$lo/lou,min = lb/d = 1.00$$

$$su1 = 0.4 * esu1_nominal \text{ ((5.5), TBDY)} = 0.032$$

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 $\text{Min}(1, 1.25 * (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs1 = fs = 555.55$$

with $E_{s1} = E_s = 200000.00$
 $y_2 = 0.00231479$
 $sh_2 = 0.008$
 $ft_2 = 666.66$
 $fy_2 = 555.55$
 $su_2 = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lo_{min} = lb/lb_{min} = 1.00$
 $su_2 = 0.4 * esu_{2_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2_nominal} = 0.08$,
 For calculation of $esu_{2_nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fs_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 555.55$
 with $E_{s2} = E_s = 200000.00$
 $y_v = 0.00231479$
 $sh_v = 0.008$
 $ft_v = 666.66$
 $fy_v = 555.55$
 $su_v = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lo_{min} = lb/ld = 1.00$
 $su_v = 0.4 * esu_{v_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{v_nominal} = 0.08$,
 considering characteristic value $fs_{yv} = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esu_{v_nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fs_{yv} = fs_v/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = fs = 555.55$
 with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b*d) * (fs_1/fc) = 0.10765806$
 $2 = A_{sl,com}/(b*d) * (fs_2/fc) = 0.10765806$
 $v = A_{sl,mid}/(b*d) * (fs_v/fc) = 0.00$
 and confined core properties:
 $b = 190.00$
 $d = 2927.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 20.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d) * (fs_1/fc) = 0.14310722$
 $2 = A_{sl,com}/(b*d) * (fs_2/fc) = 0.14310722$
 $v = A_{sl,mid}/(b*d) * (fs_v/fc) = 0.00$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_s, y_2$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.06692943$
 $Mu = MRc (4.14) = 5.5677E+009$
 $u = su (4.1) = 1.1598028E-005$

 Calculation of ratio lb/ld

Adequate Lap Length: $lb/ld \geq 1$

Calculation of Mu_1 -

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 1.1691922E-005$$

$$\mu = 6.1366E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00186094$$

$$N = 27514.027$$

$$f_c = 20.00$$

$$c_o(5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0035$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.0035$$

$$w_e(5.4c) = 0.00$$

$$a_{se}((5.4d), \text{TBDY}) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$$

$$p_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$p_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$p_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirrups, } n_{s3} = 2.00$$

$$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$$

$$p_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$p_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$p_{s3,y} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

$$\text{No stirrups, } n_{s3} = 0.00$$

$$A_{sec} = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 555.55$$

$$f_{ce} = 20.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.002$$

$c = \text{confinement factor} = 1.00$
 $y1 = 0.00231479$
 $sh1 = 0.008$
 $ft1 = 666.66$
 $fy1 = 555.55$
 $su1 = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \text{min} = lb/ld = 1.00$
 $su1 = 0.4 * esu1_nominal ((5.5), \text{TBDY}) = 0.032$
 From table 5A.1, TBDY: $esu1_nominal = 0.08$,
 For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = fs = 555.55$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00231479$
 $sh2 = 0.008$
 $ft2 = 666.66$
 $fy2 = 555.55$
 $su2 = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \text{min} = lb/lb, \text{min} = 1.00$
 $su2 = 0.4 * esu2_nominal ((5.5), \text{TBDY}) = 0.032$
 From table 5A.1, TBDY: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = fs = 555.55$
 with $Es2 = Es = 200000.00$
 $yv = 0.00231479$
 $shv = 0.008$
 $ftv = 666.66$
 $fyv = 555.55$
 $suv = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \text{min} = lb/ld = 1.00$
 $suv = 0.4 * esuv_nominal ((5.5), \text{TBDY}) = 0.032$
 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 $fsv = fs = 555.55$
 with $Esv = Es = 200000.00$
 $1 = Asl, \text{ten} / (b * d) * (fs1 / fc) = 0.10765806$
 $2 = Asl, \text{com} / (b * d) * (fs2 / fc) = 0.10765806$
 $v = Asl, \text{mid} / (b * d) * (fsv / fc) = 0.02313704$
 and confined core properties:
 $b = 190.00$
 $d = 2927.00$
 $d' = 13.00$
 $fcc (5A.2, \text{TBDY}) = 20.00$
 $cc (5A.5, \text{TBDY}) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl, \text{ten} / (b * d) * (fs1 / fc) = 0.14310722$
 $2 = Asl, \text{com} / (b * d) * (fs2 / fc) = 0.14310722$
 $v = Asl, \text{mid} / (b * d) * (fsv / fc) = 0.0307555$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < vs, y2$ - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.07442258
Mu = MRc (4.14) = 6.1366E+009
u = su (4.1) = 1.1691922E-005

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 1.1598028E-005
Mu = 5.5677E+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
Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

$$ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00034907$$

$$h2 = 250.00$$

$$As2 = Astir2 \cdot ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3,y \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00$$

$$h3 = 250.00$$

$$As3 = Astir3 \cdot ns3 = 157.0796$$

$$\text{No stirups, } ns3 = 0.00$$

$$Asec = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$fywe = 555.55$$

$$fce = 20.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.00231479$$

$$sh1 = 0.008$$

$$ft1 = 666.66$$

$$fy1 = 555.55$$

$$su1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou,min = lb/d = 1.00$$

$$su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu1_nominal = 0.08,$$

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

$$y1, sh1,ft1,fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs1 = fs = 555.55$$

$$\text{with } Es1 = Es = 200000.00$$

$$y2 = 0.00231479$$

$$sh2 = 0.008$$

$$ft2 = 666.66$$

$$fy2 = 555.55$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou,min = lb/lb,min = 1.00$$

$$su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu2_nominal = 0.08,$$

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

$$y2, sh2,ft2,fy2, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs2 = fs = 555.55$$

$$\text{with } Es2 = Es = 200000.00$$

$$yv = 0.00231479$$

$$shv = 0.008$$

$$ftv = 666.66$$

$$fyv = 555.55$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou,min = lb/d = 1.00$$

$$suv = 0.4 \cdot esuv_nominal \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esuv_nominal = 0.08,$$

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

$$yv, shv,ftv,fyv, \text{ are also multiplied by } \text{Min}(1, 1.25 \cdot (lb/d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fsv = fs = 555.55$$

$$\text{with } Esv = Es = 200000.00$$

$$1 = Asl,ten / (b \cdot d) \cdot (fs1 / fc) = 0.10765806$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.10765806$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.00$$

and confined core properties:

$$b = 190.00$$

$$d = 2927.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 20.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.14310722$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.14310722$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.00$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.06692943$$

$$\mu = M_{Rc} (4.14) = 5.5677E+009$$

$$u = s_u (4.1) = 1.1598028E-005$$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of μ_2 -

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$u = 1.1691922E-005$$

$$\mu = 6.1366E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00186094$$

$$N = 27514.027$$

$$f_c = 20.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0035$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.0035$$

$$w_e (5.4c) = 0.00$$

$$a_{se} ((5.4d), TBDY) = (a_{se1}*A_{col1} + a_{se2}*A_{col2} + a_{se3}*A_{web})/A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} = ps1,x + ps2,x + ps3,x = 0.00356047$$

$$ps1,x \text{ (column 1)} = (A_{s1}*h1/s_1)/A_c = 0.00083776$$

$$h1 = 600.00$$

As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/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 = 555.55
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00231479
sh1 = 0.008
ft1 = 666.66
fy1 = 555.55
su1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/l_d = 1.00
su1 = 0.4*esu1_nominal ((5.5), 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 = 555.55
with Es1 = Es = 200000.00
y2 = 0.00231479
sh2 = 0.008
ft2 = 666.66
fy2 = 555.55
su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/l_b,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), 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/l_d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 555.55
with Es2 = Es = 200000.00
yv = 0.00231479
shv = 0.008

$$f_{tv} = 666.66$$

$$f_{yv} = 555.55$$

$$s_{uv} = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o/l_{o,min} = l_b/l_d = 1.00$$

$$s_{uv} = 0.4 * e_{suv,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $e_{suv,nominal} = 0.08$,

considering characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY

For calculation of $e_{suv,nominal}$ and y_v , sh_v , f_{tv} , f_{yv} , it is considered characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.

y_1 , sh_1 , f_{t1} , f_{y1} , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } f_{sv} = f_s = 555.55$$

$$\text{with } E_{sv} = E_s = 200000.00$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.10765806$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.10765806$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.02313704$$

and confined core properties:

$$b = 190.00$$

$$d = 2927.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 20.00$$

$$c_c (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.14310722$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.14310722$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.0307555$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

$$s_u (4.9) = 0.07442258$$

$$M_u = M_{Rc} (4.14) = 6.1366E+009$$

$$u = s_u (4.1) = 1.1691922E-005$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 1.6794E+006$

Calculation of Shear Strength at edge 1, $V_{r1} = 1.6794E+006$

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)

$$f_c' = 20.00, \text{ but } f_c'^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$h = 250.00$$

$$d = 2400.00$$

$$l_w = 3000.00$$

$$M_u = 3.2196245E-010$$

$$V_u = 6.3108872E-029$$

$$N_u = 27514.027$$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 949449.618$

$V_{s1} = 223399.91$ is calculated for pseudo-Column 1, with:

$$d = 480.00$$

$$A_v = 157079.633$$

s = 150.00

fy = 444.44

Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs2 = 223399.91 is calculated for pseudo-Column 2, with:

d = 480.00

Av = 157079.633

s = 150.00

fy = 444.44

Vs2 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs3 = 502649.798 is calculated for web, with:

d = 1440.00

Av = 157079.633

s = 200.00

fy = 444.44

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, Vr2 = 1.6794E+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) '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 $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

h = 250.00

d = 2400.00

lw = 3000.00

Mu = 3.2196245E-010

Vu = 6.3108872E-029

Nu = 27514.027

From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 + Vs3 = 949449.618

Vs1 = 223399.91 is calculated for pseudo-Column 1, with:

d = 480.00

Av = 157079.633

s = 150.00

fy = 444.44

Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs2 = 223399.91 is calculated for pseudo-Column 2, with:

d = 480.00

Av = 157079.633

s = 150.00

fy = 444.44

Vs2 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs3 = 502649.798 is calculated for web, with:

d = 1440.00

Av = 157079.633

s = 200.00

fy = 444.44

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

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, $\gamma = 0.85$

Mean strength values are used for both shear and moment calculations.

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 500.00$

#####

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou}, \min >= 1$)

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = 0.00$

EDGE -B-

Shear Force, $V_b = 0.00$

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, $V_e/V_r = 0.28750647$

Member Controlled by Flexure ($V_e/V_r < 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 211972.373$

with

$M_{pr1} = \max(\mu_{1+}, \mu_{1-}) = 3.1796E+008$

$\mu_{1+} = 2.4327E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$\mu_{1-} = 3.1796E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

$M_{pr2} = \max(\mu_{2+}, \mu_{2-}) = 3.1796E+008$

$\mu_{2+} = 2.4327E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination

$\mu_{2-} = 3.1796E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination

Calculation of Mu1+

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\mu = 0.00019144$$

$$Mu = 2.4327E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0035$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.0035$$

$$w_e \text{ (5.4c)} = 0.00$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$$

$$p_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

No stirrups, $n_{s1} = 2.00$

$$p_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

No stirrups, $n_{s2} = 2.00$

$$p_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

No stirrups, $n_{s3} = 2.00$

$$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$$

$$p_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

No stirrups, $n_{s1} = 2.00$

$$p_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

No stirrups, $n_{s2} = 2.00$

$$p_{s3,y} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

No stirrups, $n_{s3} = 0.00$

$$A_{sec} = 750000.00$$

$s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 500.00$
 $fce = 16.00$
 From ((5.A.5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y1 = 0.00208333$
 $sh1 = 0.00805$
 $ft1 = 600.00$
 $fy1 = 500.00$
 $su1 = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \text{min} = lb/ld = 1.00$
 $su1 = 0.4 * esu1_nominal \text{ ((5.5), TBDY)} = 0.03226667$
 From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,
 For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = fs = 500.00$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00208333$
 $sh2 = 0.00805$
 $ft2 = 600.00$
 $fy2 = 500.00$
 $su2 = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \text{min} = lb/lb, \text{min} = 1.00$
 $su2 = 0.4 * esu2_nominal \text{ ((5.5), TBDY)} = 0.03226667$
 From table 5A.1, TBDY: $esu2_nominal = 0.08066667$,
 For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = fs = 500.00$
 with $Es2 = Es = 200000.00$
 $yv = 0.00208333$
 $shv = 0.00805$
 $ftv = 600.00$
 $fyv = 500.00$
 $suv = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \text{min} = lb/ld = 1.00$
 $suv = 0.4 * esuv_nominal \text{ ((5.5), TBDY)} = 0.03226667$
 From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 500.00$
 with $Esv = Es = 200000.00$
 $1 = Asl, \text{ten} / (b * d) * (fs1 / fc) = 0.11862785$
 $2 = Asl, \text{com} / (b * d) * (fs2 / fc) = 0.11862785$
 $v = Asl, \text{mid} / (b * d) * (fsv / fc) = 0.00$
 and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $fcc \text{ (5A.2, TBDY)} = 16.00$
 $cc \text{ (5A.5, TBDY)} = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl, \text{ten} / (b * d) * (fs1 / fc) = 0.14145031$

$$2 = A_{sl,com}/(b*d)*(f_s2/f_c) = 0.14145031$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.00$$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

---->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

---->

$$s_u(4.9) = 0.18965884$$

$$\mu_u = M_{Rc}(4.14) = 2.4327E+008$$

$$u = s_u(4.1) = 0.00019144$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of μ_{u1} -

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 0.00019712$$

$$\mu_u = 3.1796E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

$$c_o(5A.5, TBDY) = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0035$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.0035$$

$$w_e(5.4c) = 0.00$$

$$a_{se}((5.4d), TBDY) = (a_{se1}*A_{col1} + a_{se2}*A_{col2} + a_{se3}*A_{web})/A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$$

$$p_{s1,x} \text{ (column 1)} = (A_{s1}*h_1/s_1)/A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1}*n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$p_{s2,x} \text{ (column 2)} = (A_{s2}*h_2/s_2)/A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2}*n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$p_{s3,x} \text{ (web)} = (A_{s3}*h_3/s_3)/A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3}*n_{s3} = 0.00$$

$$\text{No stirrups, } n_{s3} = 2.00$$

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 = 500.00

fce = 16.00

From ((5.A.5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00208333

sh1 = 0.00805

ft1 = 600.00

fy1 = 500.00

su1 = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25*(lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

y2 = 0.00208333

sh2 = 0.00805

ft2 = 600.00

fy2 = 500.00

su2 = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25*(lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 500.00

with Es2 = Es = 200000.00

yv = 0.00208333

shv = 0.00805

ftv = 600.00

fyv = 500.00

suv = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esuv_nominal = 0.08066667,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of $\epsilon_{sv_nominal}$ 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 $\text{Min}(1, 1.25 \cdot (l_b/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $f_{sv} = f_s = 500.00$

with $E_{sv} = E_s = 200000.00$

$1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.11862785$

$2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.11862785$

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.08055366$

and confined core properties:

$b = 2940.00$

$d = 178.00$

$d' = 12.00$

f_{cc} (5A.2, TBDY) = 16.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

$1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.14145031$

$2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.14145031$

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.09605114$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

--->

μ_u (4.9) = 0.2130262

$M_u = M_{Rc}$ (4.14) = 3.1796E+008

$u = \mu_u$ (4.1) = 0.00019712

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of μ_{u2+}

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:

$u = 0.00019144$

$M_u = 2.4327E+008$

with full section properties:

$b = 3000.00$

$d = 208.00$

$d' = 42.00$

$v = 0.00275581$

$N = 27514.027$

$f_c = 16.00$

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: $\mu_u = 0.0035$

w_e (5.4c) = 0.00

a_{se} ((5.4d), TBDY) = $(a_{se1} \cdot A_{col1} + a_{se2} \cdot A_{col2} + a_{se3} \cdot A_{web}) / A_{sec} = 0.00$

$a_{se1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$a_{se2} = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$a_{se3} = 0$ (grid does not provide confinement)

$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$$

$$p_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$p_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$p_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirrups, } n_{s3} = 2.00$$

$$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$$

$$p_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$p_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$p_{s3,y} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

$$\text{No stirrups, } n_{s3} = 0.00$$

$$A_{sec} = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 500.00$$

$$f_{ce} = 16.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.00208333$$

$$sh_1 = 0.00805$$

$$ft_1 = 600.00$$

$$fy_1 = 500.00$$

$$su_1 = 0.03226667$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o / l_{ou,min} = l_b / l_d = 1.00$$

$$su_1 = 0.4 * esu_{1,nominal} \text{ ((5.5), TBDY)} = 0.03226667$$

$$\text{From table 5A.1, TBDY: } esu_{1,nominal} = 0.08066667,$$

For calculation of $esu_{1,nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b / l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_1 = fs = 500.00$$

$$\text{with } Es_1 = Es = 200000.00$$

$$y_2 = 0.00208333$$

$$sh_2 = 0.00805$$

$$ft_2 = 600.00$$

$$fy_2 = 500.00$$

$$su_2 = 0.03226667$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o / l_{ou,min} = l_b / l_{b,min} = 1.00$$

$$su_2 = 0.4 * esu_{2,nominal} \text{ ((5.5), TBDY)} = 0.03226667$$

$$\text{From table 5A.1, TBDY: } esu_{2,nominal} = 0.08066667,$$

For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered

characteristic value $f_{s2} = f_s/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, f_{y1} , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $f_{s2} = f_s = 500.00$

with $E_{s2} = E_s = 200000.00$

$y_v = 0.00208333$

$sh_v = 0.00805$

$ft_v = 600.00$

$f_{yv} = 500.00$

$suv = 0.03226667$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$l_o/l_{o,min} = l_b/d = 1.00$

$suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY: $esuv_{nominal} = 0.08066667$,

considering characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY

For calculation of $esuv_{nominal}$ 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 $\text{Min}(1, 1.25 \cdot (l_b/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $f_{sv} = f_s = 500.00$

with $E_{sv} = E_s = 200000.00$

1 = $Asl_{ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.11862785$

2 = $Asl_{com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.11862785$

$v = Asl_{mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$

and confined core properties:

$b = 2940.00$

$d = 178.00$

$d' = 12.00$

$f_{cc} (5A.2, TBDY) = 16.00$

$cc (5A.5, TBDY) = 0.002$

$c = \text{confinement factor} = 1.00$

1 = $Asl_{ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.14145031$

2 = $Asl_{com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.14145031$

$v = Asl_{mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.18965884$

$Mu = MRc (4.14) = 2.4327E+008$

$u = su (4.1) = 0.00019144$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of Mu_2 -

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$u = 0.00019712$

$Mu = 3.1796E+008$

with full section properties:

$b = 3000.00$

$d = 208.00$

$d' = 42.00$

$v = 0.00275581$

$N = 27514.027$

$f_c = 16.00$

$co (5A.5, TBDY) = 0.002$

Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.0035$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $c_u = 0.0035$

w_e (5.4c) = 0.00

a_{se} ((5.4d), TBDY) = $(a_{se1} \cdot A_{col1} + a_{se2} \cdot A_{col2} + a_{se3} \cdot A_{web}) / A_{sec} = 0.00$

$a_{se1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$a_{se2} = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$a_{se3} = 0$ (grid does not provide confinement)

$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x} = ps1,x + ps2,x + ps3,x = 0.00356047$

$ps1,x$ (column 1) = $(A_{s1} \cdot h1 / s_1) / A_c = 0.00083776$

$h1 = 600.00$

$A_{s1} = A_{stir1} \cdot ns1 = 157.0796$

No stirrups, $ns1 = 2.00$

$ps2,x$ (column 2) = $(A_{s2} \cdot h2 / s_2) / A_c = 0.00083776$

$h2 = 600.00$

$A_{s2} = A_{stir2} \cdot ns2 = 157.0796$

No stirrups, $ns2 = 2.00$

$ps3,x$ (web) = $(A_{s3} \cdot h3 / s_3) / A_c = 0.00188496$

$h3 = 1800.00$

$A_{s3} = A_{stir3} \cdot ns3 = 0.00$

No stirrups, $ns3 = 2.00$

$p_{sh,y} = ps1,y + ps2,y + ps3,y = 0.00069813$

$ps1,y$ (column 1) = $(A_{s1} \cdot h1 / s_1) / A_c = 0.00034907$

$h1 = 250.00$

$A_{s1} = A_{stir1} \cdot ns1 = 157.0796$

No stirrups, $ns1 = 2.00$

$ps2,y$ (column 2) = $(A_{s2} \cdot h2 / s_2) / A_c = 0.00034907$

$h2 = 250.00$

$A_{s2} = A_{stir2} \cdot ns2 = 157.0796$

No stirrups, $ns2 = 2.00$

$ps3,y$ (web) = $(A_{s3} \cdot h3 / s_3) / A_c = 0.00$

$h3 = 250.00$

$A_{s3} = A_{stir3} \cdot ns3 = 157.0796$

No stirrups, $ns3 = 0.00$

$A_{sec} = 750000.00$

$s_1 = 150.00$

$s_2 = 150.00$

$s_3 = 200.00$

$f_{ywe} = 500.00$

$f_{ce} = 16.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$

c = confinement factor = 1.00

$y1 = 0.00208333$

$sh1 = 0.00805$

$ft1 = 600.00$

$fy1 = 500.00$

$su1 = 0.03226667$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$lo/lou,min = lb/d = 1.00$

$su1 = 0.4 \cdot esu1_nominal$ ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered

characteristic value $f_{sy1} = f_{s1}/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $f_{s1} = f_s = 500.00$

with $E_{s1} = E_s = 200000.00$

$y_2 = 0.00208333$

$sh_2 = 0.00805$

$ft_2 = 600.00$

$fy_2 = 500.00$

$su_2 = 0.03226667$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$l_o/l_{o,min} = l_b/l_{b,min} = 1.00$

$su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY: $esu_{2,nominal} = 0.08066667$,

For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered

characteristic value $f_{sy2} = f_{s2}/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $f_{s2} = f_s = 500.00$

with $E_{s2} = E_s = 200000.00$

$y_v = 0.00208333$

$sh_v = 0.00805$

$ft_v = 600.00$

$fy_v = 500.00$

$su_v = 0.03226667$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$l_o/l_{o,min} = l_b/l_d = 1.00$

$su_v = 0.4 \cdot esu_{v,nominal} ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY: $esu_{v,nominal} = 0.08066667$,

considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY

For calculation of $esu_{v,nominal}$ 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 $f_{sv} = f_s = 500.00$

with $E_{sv} = E_s = 200000.00$

1 = $Asl_{ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.11862785$

2 = $Asl_{com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.11862785$

v = $Asl_{mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.08055366$

and confined core properties:

$b = 2940.00$

$d = 178.00$

$d' = 12.00$

$f_{cc} (5A.2, TBDY) = 16.00$

$cc (5A.5, TBDY) = 0.002$

c = confinement factor = 1.00

1 = $Asl_{ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.14145031$

2 = $Asl_{com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.14145031$

v = $Asl_{mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.09605114$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.2130262$

$\mu = MR_c (4.14) = 3.1796E+008$

u = $su (4.1) = 0.00019712$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 737278.61$

Calculation of Shear Strength at edge 1, $V_{r1} = 737278.61$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r1} = V_n < 0.83 \cdot f_c'^{0.5} \cdot h \cdot d$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$\mu_u / \mu - l_w / 2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$\mu_u = 1.4551920E-011$

$V_u = 0.00$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

$V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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:

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 400.00$

V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

V_f ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$

$b_w = 3000.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 737278.61$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r2} = V_n < 0.83 \cdot f_c'^{0.5} \cdot h \cdot d$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$\mu_u / \mu - l_w / 2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$\mu_u = 1.4551920E-011$

$V_u = 0.00$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

$V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

Vs2 = 41887.902 is calculated for pseudo-Column 2, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 400.00$$

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:

$$d = 200.00$$

$$A_v = 0.00$$

$$s = 200.00$$

$$f_y = 400.00$$

Vs3 has been multiplied by 2(1-s/d) ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.00$$

$$V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 1.5943E+006$$

$$b_w = 3000.00$$

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcrws

Constant Properties

Knowledge Factor, $\eta = 0.85$

According to 10.7.2.3, ASCE 41-17, shear walls with
transverse reinforcement percentage, $\eta < 0.0015$

are considered Force-Controlled and lower-bound strengths are used according to 7.5.1.3, ASCE 41-17

$$\eta = 0.00069813$$

with $\eta = \rho_{s1} + \rho_{s2} + \rho_{s3}$, being the shear reinf. ratio in a plane perpendicular to the shear axis 3

$$(\text{pseudo-col.1 } \rho_{s1} = A_{s1} \cdot b_1 / s_1 = (A_{s1} \cdot h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

$$s_1 = 150.00$$

$$\text{total area of hoops perpendicular to shear axis, } A_{s1} = 157.0796$$

$$(\text{pseudo-col.2 } \rho_{s2} = A_{s2} \cdot b_2 / s_2 = (A_{s2} \cdot h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

$$s_2 = 150.00$$

$$\text{total area of hoops perpendicular to shear axis, } A_{s2} = 157.0796$$

$$(\text{grid } \rho_{s3} = A_{s3} \cdot b_3 / s_3 = (A_{s3} \cdot h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$s_3 = 200.00$$

$$\text{total area of hoops perpendicular to shear axis, } A_{s3} = 0.00$$

$$\text{total section area, } A_c = 750000.00$$

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_b/l_d \geq 1$)
No FRP Wrapping

Stepwise Properties

Axial Force, $F = -29778.709$
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, $DbL = 17.33333$

Considering wall controlled by Shear (shear control ratio > 1),
interstorey drift provided values are calculated
Existing component: From table 7-7, ASCE 41_17: Final interstorey drift Capacity $u_{i,R} = \dots * u = 0.015$
from table 10-20: $u = 0.01764706$

with:

- Condition i (shear wall and wall segments)
- $(A_s - A_{s'}) * f_y + P / (t_w * l_w * f_c') = -0.20905235$
 $A_s = 0.00$
 $A_{s'} = 6346.017$
 $f_y = 400.00$
 $P = 29778.709$
 $t_w = 250.00$
 $l_w = 3000.00$
 $f_c = 16.00$

End Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 11

wall W1, Floor 1

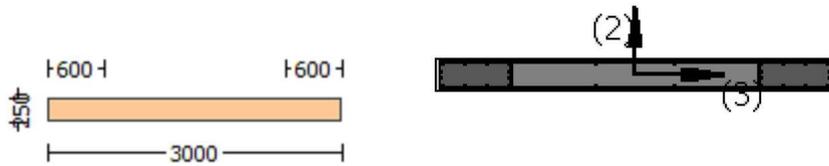
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VR_d

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcrws

Constant Properties

Knowledge Factor, $\phi = 0.85$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{o,min} = l_b/l_d \geq 1$)

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 1.0288E+008$

Shear Force, $V_a = -34425.832$

EDGE -B-

Bending Moment, $M_b = 419898.816$

Shear Force, $V_b = 34425.832$

BOTH EDGES

Axial Force, $F = -29778.709$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 0.00$

-Compression: $A_{sc} = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{st,ten} = 2865.133$

-Compression: $A_{st,com} = 2865.133$

-Middle: $A_{st,mid} = 615.7522$

Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 17.33333$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = V_n = 1.2477E+006$
From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c'^{0.5} \cdot h \cdot d = 1.4679E+006$

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw + f_vV_f'
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (11.5.4.6(d-e)), ACI 318-14: $V_c = 613367.332$

$\mu_u / \mu - l_w / 2 = 1488.331 > 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 1.0288E+008$

$V_u = 34425.832$

$N_u = 29778.709$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$

$V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

V_{s2} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s3} = 452389.342$ is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 400.00$

V_{s3} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

V_f ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$

$b_w = 250.00$

End Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 12

wall W1, Floor 1

Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (θ_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: rcrws

Constant Properties

 Knowledge Factor, $\gamma = 0.85$
 Mean strength values are used for both shear and moment calculations.
 Consequently:
 Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$
 Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$
 Concrete Elasticity, $E_c = 21019.039$
 Steel Elasticity, $E_s = 200000.00$

 Note: Especially for the calculation of moment strengths,
 the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
 Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 555.55$

 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, $L = 3000.00$
 Secondary Member
 Smooth Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Adequate Lap Length ($l_o/l_{ou}, \min >= 1$)
 No FRP Wrapping

 Stepwise Properties

 At local axis: 3
 EDGE -A-
 Shear Force, $V_a = -6.3108872E-029$
 EDGE -B-
 Shear Force, $V_b = 6.3108872E-029$
 BOTH EDGES
 Axial Force, $F = -27514.027$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{sl,t} = 0.00$
 -Compression: $A_{sl,c} = 6346.017$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{sl,ten} = 2865.133$
 -Compression: $A_{sl,com} = 2865.133$
 -Middle: $A_{sl,mid} = 0.00$
 (According to 10.7.2.3 $A_{sl,mid}$ is setted equal to zero)

Calculation of Shear Capacity ratio , $V_e/V_r = 2.43595$

Member Controlled by Shear ($V_e/V_r > 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 4.0910E+006$
with

$M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 6.1366E+009$

$\mu_{u1+} = 5.5677E+009$, 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

$\mu_{u1-} = 6.1366E+009$, 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

$M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 6.1366E+009$

$\mu_{u2+} = 5.5677E+009$, 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

$\mu_{u2-} = 6.1366E+009$, 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_u according to 4.1, Biskinis/Fardis 2013:

$\mu_u = 1.1598028E-005$

$M_u = 5.5677E+009$

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$

$v = 0.00186094$

$N = 27514.027$

$f_c = 20.00$

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)

$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$

$p_{s1,x}$ (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 stirrups, $n_{s1} = 2.00$

$p_{s2,x}$ (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 stirrups, $n_{s2} = 2.00$

$p_{s3,x}$ (web) = $(A_{s3} * h_3 / s_3) / A_c = 0.00188496$

$h_3 = 1800.00$

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 = 555.55
fce = 20.00

From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00

y1 = 0.00231479
sh1 = 0.008
ft1 = 666.66
fy1 = 555.55
su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.

with fs1 = fs = 555.55

with Es1 = Es = 200000.00

y2 = 0.00231479
sh2 = 0.008
ft2 = 666.66
fy2 = 555.55
su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.

with fs2 = fs = 555.55

with Es2 = Es = 200000.00

yv = 0.00231479
shv = 0.008
ftv = 666.66
fyv = 555.55
suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25*(lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 555.55$
 with $Esv = Es = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.10765806$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.10765806$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00$

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
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.14310722$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.14310722$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00$

Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied

--->
 su (4.9) = 0.06692943
 $Mu = MRc$ (4.14) = 5.5677E+009
 $u = su$ (4.1) = 1.1598028E-005

 Calculation of ratio lb/d

 Adequate Lap Length: $lb/d \geq 1$

 Calculation of $Mu1$ -

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 1.1691922E-005$
 $Mu = 6.1366E+009$

 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

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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 stirrups, ns1 = 2.00

ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776

h2 = 600.00

As2 = Astir2*ns2 = 157.0796

No stirrups, ns2 = 2.00

ps3,x (web) = (As3*h3/s_3)/Ac = 0.00188496

h3 = 1800.00

As3 = Astir3*ns3 = 0.00

No stirrups, 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 stirrups, ns1 = 2.00

ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907

h2 = 250.00

As2 = Astir2*ns2 = 157.0796

No stirrups, ns2 = 2.00

ps3,y (web) = (As3*h3/s_3)/Ac = 0.00

h3 = 250.00

As3 = Astir3*ns3 = 157.0796

No stirrups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 555.55

fce = 20.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00231479

sh1 = 0.008

ft1 = 666.66

fy1 = 555.55

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.

with fs1 = fs = 555.55

with Es1 = Es = 200000.00

y2 = 0.00231479

sh2 = 0.008

ft2 = 666.66

fy2 = 555.55

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $es_{u2_nominal} = 0.08$,

For calculation of $es_{u2_nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered characteristic value $fs_{y2} = fs_2/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_2 = fs = 555.55$

with $Es_2 = Es = 200000.00$

$y_v = 0.00231479$

$sh_v = 0.008$

$ft_v = 666.66$

$fy_v = 555.55$

$s_{uv} = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$lo/lo_{u,min} = lb/d = 1.00$

$s_{uv} = 0.4 \cdot es_{uv_nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $es_{uv_nominal} = 0.08$,

considering characteristic value $fs_{yv} = fs_v/1.2$, from table 5.1, TBDY

For calculation of $es_{uv_nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered

characteristic value $fs_{yv} = fs_v/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_v = fs = 555.55$

with $Es_v = Es = 200000.00$

1 = $As_{l,ten}/(b \cdot d) \cdot (fs_1/f_c) = 0.10765806$

2 = $As_{l,com}/(b \cdot d) \cdot (fs_2/f_c) = 0.10765806$

$v = As_{l,mid}/(b \cdot d) \cdot (fs_v/f_c) = 0.02313704$

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 = $As_{l,ten}/(b \cdot d) \cdot (fs_1/f_c) = 0.14310722$

2 = $As_{l,com}/(b \cdot d) \cdot (fs_2/f_c) = 0.14310722$

$v = As_{l,mid}/(b \cdot d) \cdot (fs_v/f_c) = 0.0307555$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$s_u (4.9) = 0.07442258$

$M_u = MR_c (4.14) = 6.1366E+009$

$u = s_u (4.1) = 1.1691922E-005$

Calculation of ratio lb/d

Adequate Lap Length: $lb/d \geq 1$

Calculation of M_{u2+}

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 1.1598028E-005$

$M_u = 5.5677E+009$

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: $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0035$

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 = $\text{Min}(psh,x, psh,y) = 0.00069813$

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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 = $A_{stir1} * ns1 = 157.0796$

No stirrups, ns1 = 2.00

ps2,x (column 2) = $(As2 * h2 / s_2) / Ac = 0.00083776$

h2 = 600.00

As2 = $A_{stir2} * ns2 = 157.0796$

No stirrups, ns2 = 2.00

ps3,x (web) = $(As3 * h3 / s_3) / Ac = 0.00188496$

h3 = 1800.00

As3 = $A_{stir3} * ns3 = 0.00$

No stirrups, 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 = $A_{stir1} * ns1 = 157.0796$

No stirrups, ns1 = 2.00

ps2,y (column 2) = $(As2 * h2 / s_2) / Ac = 0.00034907$

h2 = 250.00

As2 = $A_{stir2} * ns2 = 157.0796$

No stirrups, ns2 = 2.00

ps3,y (web) = $(As3 * h3 / s_3) / Ac = 0.00$

h3 = 250.00

As3 = $A_{stir3} * ns3 = 157.0796$

No stirrups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 555.55

fce = 20.00

From ((5.A5), TBDY), TBDY: $cc = 0.002$

c = confinement factor = 1.00

y1 = 0.00231479

sh1 = 0.008

ft1 = 666.66

fy1 = 555.55

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

su1 = $0.4 * esu1_nominal$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25*(lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = fs = 555.55$

with $Es1 = Es = 200000.00$

$y2 = 0.00231479$

$sh2 = 0.008$

$ft2 = 666.66$

$fy2 = 555.55$

$su2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$

and also multiplied by the $shear_factor$ according to 15.7.1.4, with

$Shear_factor = 1.00$

$lo/lou, min = lb/lb, min = 1.00$

$su2 = 0.4*esu2_nominal$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25*(lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs2 = fs = 555.55$

with $Es2 = Es = 200000.00$

$yv = 0.00231479$

$shv = 0.008$

$ftv = 666.66$

$fyv = 555.55$

$suv = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$

and also multiplied by the $shear_factor$ according to 15.7.1.4, with

$Shear_factor = 1.00$

$lo/lou, min = lb/d = 1.00$

$suv = 0.4*esuv_nominal$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esuv_nominal = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered

characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25*(lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fsv = fs = 555.55$

with $Esv = Es = 200000.00$

1 = $Asl, ten/(b*d)*(fs1/fc) = 0.10765806$

2 = $Asl, com/(b*d)*(fs2/fc) = 0.10765806$

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 = $Asl, ten/(b*d)*(fs1/fc) = 0.14310722$

2 = $Asl, com/(b*d)*(fs2/fc) = 0.14310722$

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) = 0.06692943

$Mu = MRc$ (4.14) = 5.5677E+009

u = su (4.1) = 1.1598028E-005

Calculation of ratio lb/d

Adequate Lap Length: $lb/d \geq 1$

Calculation of Mu2-

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\mu = 1.1691922E-005$$

$$Mu = 6.1366E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00186094$$

$$N = 27514.027$$

$$f_c = 20.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu, c_o) = 0.0035$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu = 0.0035$$

$$w_e \text{ (5.4c)} = 0.00$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$s_{h1} = 150.00$$

$$b_{o1} = 190.00$$

$$h_{o1} = 540.00$$

$$b_{i21} = 655400.00$$

$$a_{se2} = 0.00$$

$$s_{h2} = 150.00$$

$$b_{o2} = 190.00$$

$$h_{o2} = 540.00$$

$$b_{i22} = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$$

$$p_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

No stirrups, $n_{s1} = 2.00$

$$p_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

No stirrups, $n_{s2} = 2.00$

$$p_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

No stirrups, $n_{s3} = 2.00$

$$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$$

$$p_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

No stirrups, $n_{s1} = 2.00$

$$p_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

No stirrups, $n_{s2} = 2.00$

$$p_{s3,y} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

No stirrups, $n_{s3} = 0.00$

$$A_{sec} = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 555.55$$

$$f_{ce} = 20.00$$

From ((5.A.5), TBDY), TBDY: $cc = 0.002$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.00231479$$

$$sh_1 = 0.008$$

$$ft_1 = 666.66$$

$$fy_1 = 555.55$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_0/l_{ou,min} = l_b/l_d = 1.00$$

$$su_1 = 0.4 * esu_{1,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esu_{1,nominal} = 0.08$,

For calculation of $esu_{1,nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_1 = fs = 555.55$$

$$\text{with } Es_1 = Es = 200000.00$$

$$y_2 = 0.00231479$$

$$sh_2 = 0.008$$

$$ft_2 = 666.66$$

$$fy_2 = 555.55$$

$$su_2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_0/l_{ou,min} = l_b/l_{b,min} = 1.00$$

$$su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,

For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_2 = fs = 555.55$$

$$\text{with } Es_2 = Es = 200000.00$$

$$y_v = 0.00231479$$

$$sh_v = 0.008$$

$$ft_v = 666.66$$

$$fy_v = 555.55$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_0/l_{ou,min} = l_b/l_d = 1.00$$

$$suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered

characteristic value $fsy_v = fsv/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = fs = 555.55$$

$$\text{with } Es_v = Es = 200000.00$$

$$1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.10765806$$

$$2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.10765806$$

$$v = Asl_{mid}/(b*d) * (fsv/fc) = 0.02313704$$

and confined core properties:

$$b = 190.00$$

$$d = 2927.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 20.00$$

$$cc (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.14310722$$

$$2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.14310722$$

$$v = A_s l_{mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.0307555$$

Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u(4.9) = 0.07442258$$

$$M_u = M_{Rc}(4.14) = 6.1366E+009$$

$$u = s_u(4.1) = 1.1691922E-005$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 1.6794E+006$

Calculation of Shear Strength at edge 1, $V_{r1} = 1.6794E+006$

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_vV_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)

$$f_c' = 20.00, \text{ but } f_c'^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$h = 250.00$$

$$d = 2400.00$$

$$l_w = 3000.00$$

$$M_u = 3.2196245E-010$$

$$V_u = 6.3108872E-029$$

$$N_u = 27514.027$$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 949449.618$

$V_{s1} = 223399.91$ is calculated for pseudo-Column 1, with:

$$d = 480.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 444.44$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 223399.91$ is calculated for pseudo-Column 2, with:

$$d = 480.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 444.44$$

V_{s2} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s3} = 502649.798$ is calculated for web, with:

$$d = 1440.00$$

$$A_v = 157079.633$$

$$s = 200.00$$

$$f_y = 444.44$$

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, $V_{r2} = 1.6794E+006$

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_vV_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)
 $h = 250.00$
 $d = 2400.00$
 $l_w = 3000.00$
 $M_u = 3.2196245E-010$
 $V_u = 6.3108872E-029$
 $N_u = 27514.027$
From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 949449.618$
 $V_{s1} = 223399.91$ is calculated for pseudo-Column 1, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 444.44$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 223399.91$ is calculated for pseudo-Column 2, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 444.44$
 V_{s2} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s3} = 502649.798$ is calculated for web, with:
 $d = 1440.00$
 $A_v = 157079.633$
 $s = 200.00$
 $f_y = 444.44$
 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 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, $\phi = 0.85$
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 16.00$
Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 400.00$
Concrete Elasticity, $E_c = 21019.039$
Steel Elasticity, $E_s = 200000.00$

Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 500.00$

Total Height, $H_{tot} = 3000.00$
Edges Width, $W_{edg} = 250.00$
Edges Height, $H_{edg} = 600.00$
Web Width, $W_{web} = 250.00$
Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.00
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_o/l_{ou}, \min \geq 1$)
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = 0.00$
EDGE -B-
Shear Force, $V_b = 0.00$
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 , $V_e/V_r = 0.28750647$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 211972.373$
with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 3.1796E+008$
 $\mu_{u1+} = 2.4327E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
 $\mu_{u1-} = 3.1796E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 3.1796E+008$
 $\mu_{u2+} = 2.4327E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
 $\mu_{u2-} = 3.1796E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

Calculation of μ_{u1+}

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:

$\mu_u = 0.00019144$
 $\mu_u = 2.4327E+008$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $f_c = 16.00$
 c_o (5A.5, TBDY) = 0.002
Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, c_c) = 0.0035$
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
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
Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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 stirrups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776
h2 = 600.00
As2 = Astir2*ns2 = 157.0796
No stirrups, ns2 = 2.00
ps3,x (web) = (As3*h3/s_3)/Ac = 0.00188496
h3 = 1800.00
As3 = Astir3*ns3 = 0.00
No stirrups, 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 stirrups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
h2 = 250.00
As2 = Astir2*ns2 = 157.0796
No stirrups, ns2 = 2.00
ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
h3 = 250.00
As3 = Astir3*ns3 = 157.0796
No stirrups, ns3 = 0.00

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 500.00
fce = 16.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00208333
sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00

$$su_2 = 0.03226667$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_o/l_{o,min} = l_b/l_{b,min} = 1.00$$

$$su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.03226667$$

From table 5A.1, TBDY: $esu_{2,nominal} = 0.08066667$,

For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_2 = fs = 500.00$$

$$\text{with } Es_2 = Es = 200000.00$$

$$yv = 0.00208333$$

$$shv = 0.00805$$

$$ftv = 600.00$$

$$fyv = 500.00$$

$$suv = 0.03226667$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_o/l_{o,min} = l_b/l_d = 1.00$$

$$suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.03226667$$

From table 5A.1, TBDY: $esuv_{nominal} = 0.08066667$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_{nominal}$ and yv, shv, ftv, fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = fs = 500.00$$

$$\text{with } Esv = Es = 200000.00$$

$$1 = A_{sl,ten}/(b*d) * (fs_1/fc) = 0.11862785$$

$$2 = A_{sl,com}/(b*d) * (fs_2/fc) = 0.11862785$$

$$v = A_{sl,mid}/(b*d) * (fsv/fc) = 0.00$$

and confined core properties:

$$b = 2940.00$$

$$d = 178.00$$

$$d' = 12.00$$

$$fcc (5A.2, TBDY) = 16.00$$

$$cc (5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{sl,ten}/(b*d) * (fs_1/fc) = 0.14145031$$

$$2 = A_{sl,com}/(b*d) * (fs_2/fc) = 0.14145031$$

$$v = A_{sl,mid}/(b*d) * (fsv/fc) = 0.00$$

Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)

---->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

---->

$$su (4.9) = 0.18965884$$

$$Mu = MRc (4.14) = 2.4327E+008$$

$$u = su (4.1) = 0.00019144$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Mu_1 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 0.00019712$$

$$Mu = 3.1796E+008$$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $f_c = 16.00$
 $c_o (5A.5, TBDY) = 0.002$
 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)

$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$

$p_{s1,x} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$

$h_1 = 600.00$

$A_{s1} = A_{stir1} * n_{s1} = 157.0796$

No stirrups, $n_{s1} = 2.00$

$p_{s2,x} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$

$h_2 = 600.00$

$A_{s2} = A_{stir2} * n_{s2} = 157.0796$

No stirrups, $n_{s2} = 2.00$

$p_{s3,x} (\text{web}) = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$

$h_3 = 1800.00$

$A_{s3} = A_{stir3} * n_{s3} = 0.00$

No stirrups, $n_{s3} = 2.00$

 $p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$

$p_{s1,y} (\text{column 1}) = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$

$h_1 = 250.00$

$A_{s1} = A_{stir1} * n_{s1} = 157.0796$

No stirrups, $n_{s1} = 2.00$

$p_{s2,y} (\text{column 2}) = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$

$h_2 = 250.00$

$A_{s2} = A_{stir2} * n_{s2} = 157.0796$

No stirrups, $n_{s2} = 2.00$

$p_{s3,y} (\text{web}) = (A_{s3} * h_3 / s_3) / A_c = 0.00$

$h_3 = 250.00$

$A_{s3} = A_{stir3} * n_{s3} = 157.0796$

No stirrups, $n_{s3} = 0.00$

 $A_{sec} = 750000.00$

$s_1 = 150.00$

$s_2 = 150.00$

$s_3 = 200.00$

$f_{ywe} = 500.00$

$f_{ce} = 16.00$

From ((5.A5), TBDY), TBDY: $c_c = 0.002$

$c = \text{confinement factor} = 1.00$

$y_1 = 0.00208333$

$sh_1 = 0.00805$

$ft_1 = 600.00$

$fy_1 = 500.00$

su1 = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

y2 = 0.00208333

sh2 = 0.00805

ft2 = 600.00

fy2 = 500.00

su2 = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 500.00

with Es2 = Es = 200000.00

yv = 0.00208333

shv = 0.00805

ftv = 600.00

fyv = 500.00

suv = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esuv_nominal = 0.08066667,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered

characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = fs = 500.00

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785

2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785

v = Asl,mid/(b*d)*(fsv/fc) = 0.08055366

and confined core properties:

b = 2940.00

d = 178.00

d' = 12.00

fcc (5A.2, TBDY) = 16.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031

2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031

v = Asl,mid/(b*d)*(fsv/fc) = 0.09605114

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

v < vs,c - RHS eq.(4.5) is satisfied

su (4.9) = 0.2130262

Mu = MRc (4.14) = 3.1796E+008

u = su (4.1) = 0.00019712

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of μ_{2+}

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\mu = 0.00019144$$

$$\mu_{2+} = 2.4327E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0035$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.0035$$

$$w_e \text{ (5.4c)} = 0.00$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi_{2,1} = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi_{2,2} = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$$

$$p_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$p_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$p_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirrups, } n_{s3} = 2.00$$

$$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$$

$$p_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$p_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$p_{s3,y} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

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 = 500.00

fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00208333

sh1 = 0.00805

ft1 = 600.00

fy1 = 500.00

su1 = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

y2 = 0.00208333

sh2 = 0.00805

ft2 = 600.00

fy2 = 500.00

su2 = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 500.00

with Es2 = Es = 200000.00

yv = 0.00208333

shv = 0.00805

ftv = 600.00

fyv = 500.00

suv = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esuv_nominal = 0.08066667,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = fs = 500.00

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785

2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785

v = Asl,mid/(b*d)*(fsv/fc) = 0.00

and confined core properties:

b = 2940.00

d = 178.00

d' = 12.00
fcc (5A.2, TBDY) = 16.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031
2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)

---->
v < vs,c - RHS eq.(4.5) is satisfied

---->
su (4.9) = 0.18965884
Mu = MRc (4.14) = 2.4327E+008
u = su (4.1) = 0.00019144

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu2-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 0.00019712
Mu = 3.1796E+008

with full section properties:

b = 3000.00
d = 208.00
d' = 42.00
v = 0.00275581
N = 27514.027
fc = 16.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0035
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0035
we (5.4c) = 0.00
ase ((5.4d), TBDY) = (ase1*Acol1+ase2*Acol2+ase3*Aweb)/Asec = 0.00
ase1 = 0.00
sh_1 = 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
Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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) = $(As3 \cdot h3 / s_3) / Ac = 0.00188496$
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) = $(As1 \cdot h1 / s_1) / Ac = 0.00034907$
h1 = 250.00
As1 = Astir1 * 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 * ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,y (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00$
h3 = 250.00
As3 = Astir3 * ns3 = 157.0796
No stirups, ns3 = 0.00

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 500.00
fce = 16.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00208333
sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 1.00
su1 = $0.4 \cdot esu1_nominal ((5.5), TBDY) = 0.03226667$
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.
with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = $0.4 \cdot esu2_nominal ((5.5), TBDY) = 0.03226667$
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esuv_nominal = 0.08066667,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = fs = 500.00

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785

2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785

v = Asl,mid/(b*d)*(fsv/fc) = 0.08055366

and confined core properties:

b = 2940.00

d = 178.00

d' = 12.00

fcc (5A.2, TBDY) = 16.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031

2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031

v = Asl,mid/(b*d)*(fsv/fc) = 0.09605114

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

v < vs,c - RHS eq.(4.5) is satisfied

su (4.9) = 0.2130262

Mu = MRc (4.14) = 3.1796E+008

u = su (4.1) = 0.00019712

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 737278.61

Calculation of Shear Strength at edge 1, Vr1 = 737278.61

From (22.5.1.1) and 11.5.4.3, ACI 318-14: Vr1 = 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 = 653502.805

Mu/Vu-lw/2 = 0.00 <= 0

= 1 (normal-weight concrete)

fc' = 16.00, but fc'^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)

h = 3000.00

d = 200.00

lw = 250.00

Mu = 1.4551920E-011

Vu = 0.00

Nu = 27514.027

From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 + Vs3 = 83775.804

Vs1 = 41887.902 is calculated for pseudo-Column 1, with:

d = 200.00

Av = 157079.633

s = 150.00

fy = 400.00

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 = 41887.902 is calculated for pseudo-Column 2, with:

d = 200.00

Av = 157079.633

s = 150.00

fy = 400.00

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 = 400.00

Vs3 has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$

bw = 3000.00

Calculation of Shear Strength at edge 2, Vr2 = 737278.61

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_r2 = V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d$

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (11.5.4.6(d-e)), ACI 318-14: Vc = 653502.805

$\mu_u / \mu_u - l_w / 2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

h = 3000.00

d = 200.00

lw = 250.00

$\mu_u = 1.4551920E-011$

Vu = 0.00

Nu = 27514.027

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

Vs1 = 41887.902 is calculated for pseudo-Column 1, with:

d = 200.00

Av = 157079.633

s = 150.00

fy = 400.00

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 = 41887.902 is calculated for pseudo-Column 2, with:

d = 200.00

Av = 157079.633

s = 150.00

fy = 400.00

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 = 400.00

Vs3 has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$

bw = 3000.00

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcrws

Constant Properties

Knowledge Factor, $\gamma = 0.85$

According to 10.7.2.3, ASCE 41-17, shear walls with transverse reinforcement percentage, $\rho_t < 0.0015$

are considered Force-Controlled and lower-bound strengths are used according to 7.5.1.3, ASCE 41-17

$\rho_t = 0.00069813$

with $\rho_t = \rho_{t1} + \rho_{t2} + \rho_{t3}$, being the shear reinf. ratio in a plane perpendicular to the shear axis 2

(pseudo-col.1 $\rho_{t1} = A_{s1} \cdot b_1 / s_1 = (A_{s1} \cdot h_1 / s_1) / A_c = 0.00034907$

$h_1 = 250.00$

$s_1 = 150.00$

total area of hoops perpendicular to shear axis, $A_{s1} = 157.0796$

(pseudo-col.2 $\rho_{t2} = A_{s2} \cdot b_2 / s_2 = (A_{s2} \cdot h_2 / s_2) / A_c = 0.00034907$

$h_2 = 250.00$

$s_2 = 150.00$

total area of hoops perpendicular to shear axis, $A_{s2} = 157.0796$

(grid $\rho_{t3} = A_{s3} \cdot b_3 / s_3 = (A_{s3} \cdot h_3 / s_3) / A_c = 0.00$

$h_3 = 250.00$

$s_3 = 200.00$

total area of hoops perpendicular to shear axis, $A_{s3} = 0.00$

total section area, $A_c = 750000.00$

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_b / d \geq 1$)

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = -9.8133593E-011$

Shear Force, $V_2 = 7.3960296E-015$

Shear Force, $V_3 = -34425.832$

Axial Force, $F = -29778.709$

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, $D_bL = 17.20$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_{,R} = \gamma \cdot u = 0.00838092$

$u = \gamma \cdot u + \rho = 0.0098599$

- Calculation of y -

$$y = (M_y * I_p) / (E I)_{Eff} = 0.0018599 \text{ ((10-5), ASCE 41-17)}$$
$$M_y = 2.2270E+008$$
$$(E I)_{Eff} = 0.35 * E_c * I \text{ (table 10-5)}$$
$$E_c * I = 8.2106E+013$$
$$I_p = 0.5 * d = 0.5 * (0.8 * h) = 240.00$$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$$y = \text{Min}(y_{ten}, y_{com})$$
$$y_{ten} = 1.2995450E-005$$

with $f_y = 400.00$

$$d = 208.00$$
$$y = 0.26009605$$
$$A = 0.01028921$$
$$B = 0.00623102$$

with $p_t = 0.00379609$

$$p_c = 0.00379609$$
$$p_v = 0.00257772$$
$$N = 29778.709$$
$$b = 3000.00$$
$$" = 0.20192308$$
$$y_{comp} = 2.5439724E-005$$

with $f_c = 16.00$

$$E_c = 21019.039$$
$$y = 0.25894283$$
$$A = 0.00999575$$
$$B = 0.00611172$$

with $E_s = 200000.00$

Calculation of ratio I_b/I_d

Adequate Lap Length: $I_b/I_d \geq 1$

- Calculation of p -

Considering wall controlled by flexure (shear control ratio ≤ 1),
from table 10-19: $p = 0.008$

with:

- Condition i (shear wall and wall segments)

$$-(A_s - A_s') * f_y + P / (t_w * I_w * f_c') = -0.20905235$$

$$A_s = 0.00$$

$$A_s' = 6346.017$$

$$f_y = 400.00$$

$$P = 29778.709$$

$$t_w = 3000.00$$

$$I_w = 250.00$$

$$f_c = 16.00$$

$$-V / (t_w * I_w * f_c^{0.5}) = 2.9689345E-020, \text{ NOTE: units in lb \& in}$$

- 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:

$$V_{w1} = 83775.804$$

$$s_1 = 150.00$$

Boundary Element 2:

$$V_{w2} = 83775.804$$

$$s_2 = 150.00$$

Grid Shear Force, $V_w3 = 0.00$

Concrete Shear Force, $V_c = 124655.651$

(The variables above have already been given in Shear control ratio calculation)

Mean diameter of all bars, $d_b = 17.33333$

Design Shear Force, $V = 7.3960296E-015$

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: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (d)

Section Type: rcrws

Constant Properties

Knowledge Factor, $\gamma = 0.85$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

Total Height, Htot = 3000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 600.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_o/l_{ou,min} = l_b/l_d \geq 1$)
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -9.8133593E-011
Shear Force, Va = 7.3960296E-015
EDGE -B-
Bending Moment, Mb = 1.1776172E-010
Shear Force, Vb = -7.3960296E-015
BOTH EDGES
Axial Force, F = -29778.709
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Asl,t = 0.00
-Compression: Asl,c = 6346.017
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 2368.761
-Compression: Asl,com = 2368.761
-Middle: Asl,mid = 1608.495
Mean Diameter of Tension Reinforcement, DbL,ten = 17.20

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = $V_n = 176501.927$
From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d = 207649.326$

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: $V_c = 123873.522$
 $M_u/V_u - l_w/2 = 15797.289 > 0$
= 1 (normal-weight concrete)
 $f_c' = 16.00$, but $f_c' \cdot 0.5 \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
h = 3000.00
d = 200.00
lw = 250.00
Mu = 1.1776172E-010
Vu = 7.3960296E-015
Nu = 29778.709
From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$
Vs1 = 41887.902 is calculated for pseudo-Column 1, with:
d = 200.00
Av = 157079.633
s = 150.00
fy = 400.00
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 = 41887.902 is calculated for pseudo-Column 2, with:
d = 200.00
Av = 157079.633
s = 150.00
fy = 400.00
Vs2 has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$V_{s3} = 0.00$ is calculated for web, with:

$$d = 200.00$$

$$A_v = 0.00$$

$$s = 200.00$$

$$f_y = 400.00$$

V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.00$$

$$V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$$

From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$

$$b_w = 3000.00$$

End Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (d)

Calculation No. 14

wall W1, Floor 1

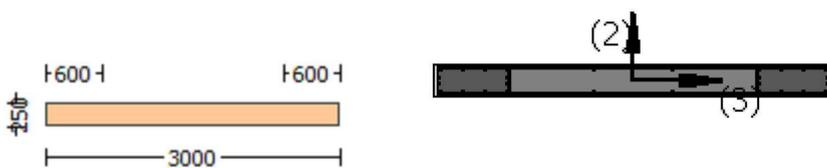
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (θ)

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: rcrcws

Constant Properties

Knowledge Factor, $\phi = 0.85$

Mean strength values are used for both shear and moment calculations.

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 555.55$

#####

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, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou, min} > 1$)

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = -6.3108872E-029$

EDGE -B-

Shear Force, $V_b = 6.3108872E-029$

BOTH EDGES

Axial Force, $F = -27514.027$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{sl, ten} = 0.00$

-Compression: $A_{sl, com} = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl, ten} = 2865.133$

-Compression: $A_{sl, com} = 2865.133$

-Middle: $A_{sl, mid} = 0.00$

(According to 10.7.2.3 $A_{sl, mid}$ is setted equal to zero)

Calculation of Shear Capacity ratio , $V_e/V_r = 2.43595$

Member Controlled by Shear ($V_e/V_r > 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 4.0910E+006$
with

$M_{pr1} = \text{Max}(M_{u1+} , M_{u1-}) = 6.1366E+009$

$M_{u1+} = 5.5677E+009$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination

$M_{u1-} = 6.1366E+009$, 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

$M_{pr2} = \text{Max}(M_{u2+} , M_{u2-}) = 6.1366E+009$

$M_{u2+} = 5.5677E+009$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination

$M_{u2-} = 6.1366E+009$, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

Calculation of M_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$\phi_u = 1.1598028E-005$

$M_u = 5.5677E+009$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00186094$$

$$N = 27514.027$$

$$f_c = 20.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0035$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.0035$$

$$w_e \text{ (5.4c)} = 0.00$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$s_{h_1} = 150.00$$

$$b_{o_1} = 190.00$$

$$h_{o_1} = 540.00$$

$$b_{i2_1} = 655400.00$$

$$a_{se2} = 0.00$$

$$s_{h_2} = 150.00$$

$$b_{o_2} = 190.00$$

$$h_{o_2} = 540.00$$

$$b_{i2_2} = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$$

$$p_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_{_1}) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

No stirrups, $n_{s1} = 2.00$

$$p_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_{_2}) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

No stirrups, $n_{s2} = 2.00$

$$p_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_{_3}) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

No stirrups, $n_{s3} = 2.00$

$$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$$

$$p_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_{_1}) / A_c = 0.00034907$$

$$h_1 = 250.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

No stirrups, $n_{s1} = 2.00$

$$p_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_{_2}) / A_c = 0.00034907$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

No stirrups, $n_{s2} = 2.00$

$$p_{s3,y} \text{ (web)} = (A_{s3} * h_3 / s_{_3}) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

No stirrups, $n_{s3} = 0.00$

$$A_{sec} = 750000.00$$

$$s_{_1} = 150.00$$

$$s_{_2} = 150.00$$

$$s_{_3} = 200.00$$

$$f_{ywe} = 555.55$$

$$f_{ce} = 20.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.00231479$$

$$s_{h1} = 0.008$$

$$f_{t1} = 666.66$$

$f_{y1} = 555.55$
 $s_{u1} = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 1.00$
 $s_{u1} = 0.4 * e_{s1_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $e_{s1_nominal} = 0.08$,
 For calculation of $e_{s1_nominal}$ and y_1, sh_1, ft_1, f_{y1} , it is considered
 characteristic value $f_{s1} = f_s/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, f_{y1} , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{s1} = f_s = 555.55$
 with $E_{s1} = E_s = 200000.00$
 $y_2 = 0.00231479$
 $sh_2 = 0.008$
 $ft_2 = 666.66$
 $f_{y2} = 555.55$
 $s_{u2} = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_{b,min} = 1.00$
 $s_{u2} = 0.4 * e_{s2_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $e_{s2_nominal} = 0.08$,
 For calculation of $e_{s2_nominal}$ and y_2, sh_2, ft_2, f_{y2} , it is considered
 characteristic value $f_{s2} = f_s/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, f_{y1} , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{s2} = f_s = 555.55$
 with $E_{s2} = E_s = 200000.00$
 $y_v = 0.00231479$
 $sh_v = 0.008$
 $ft_v = 666.66$
 $f_{y_v} = 555.55$
 $s_{u_v} = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 1.00$
 $s_{u_v} = 0.4 * e_{s_{u_v}_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $e_{s_{u_v}_nominal} = 0.08$,
 considering characteristic value $f_{s_{u_v}} = f_{s_v}/1.2$, from table 5.1, TBDY
 For calculation of $e_{s_{u_v}_nominal}$ and y_v, sh_v, ft_v, f_{y_v} , it is considered
 characteristic value $f_{s_{u_v}} = f_{s_v}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, f_{y1} , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{s_v} = f_s = 555.55$
 with $E_{s_v} = E_s = 200000.00$
 $1 = A_{s1,ten}/(b*d)*(f_{s1}/f_c) = 0.10765806$
 $2 = A_{s1,com}/(b*d)*(f_{s2}/f_c) = 0.10765806$
 $v = A_{s1,mid}/(b*d)*(f_{s_v}/f_c) = 0.00$
 and confined core properties:
 $b = 190.00$
 $d = 2927.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 20.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{s1,ten}/(b*d)*(f_{s1}/f_c) = 0.14310722$
 $2 = A_{s1,com}/(b*d)*(f_{s2}/f_c) = 0.14310722$
 $v = A_{s1,mid}/(b*d)*(f_{s_v}/f_c) = 0.00$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $s_u (4.9) = 0.06692943$
 $M_u = M_{Rc} (4.14) = 5.5677E+009$
 $u = s_u (4.1) = 1.1598028E-005$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of μ_{u1}

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:

$$\mu_u = 1.1691922E-005$$

$$\mu_u = 6.1366E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00186094$$

$$N = 27514.027$$

$$f_c = 20.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu_u: \mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, c_c) = 0.0035$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu_u = 0.0035$$

$$\mu_u \text{ (5.4c)} = 0.00$$

$$\mu_u \text{ ((5.4d), TBDY)} = (\mu_{u1} * A_{col1} + \mu_{u2} * A_{col2} + \mu_{u3} * A_{web}) / A_{sec} = 0.00$$

$$\mu_{u1} = 0.00$$

$$h_{1,1} = 150.00$$

$$b_{o,1} = 190.00$$

$$h_{o,1} = 540.00$$

$$b_{i2,1} = 655400.00$$

$$\mu_{u2} = 0.00$$

$$h_{1,2} = 150.00$$

$$b_{o,2} = 190.00$$

$$h_{o,2} = 540.00$$

$$b_{i2,2} = 655400.00$$

$$\mu_{u3} = 0 \text{ (grid does not provide confinement)}$$

$$\mu_{psh,min} = \text{Min}(\mu_{psh,x}, \mu_{psh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $\mu_{psh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\mu_{psh,x} = \mu_{p1,x} + \mu_{p2,x} + \mu_{p3,x} = 0.00356047$$

$$\mu_{p1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$\mu_{p2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$\mu_{p3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirrups, } n_{s3} = 2.00$$

$$\mu_{psh,y} = \mu_{p1,y} + \mu_{p2,y} + \mu_{p3,y} = 0.00069813$$

$$\mu_{p1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$\mu_{p2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$ps_{3,y}(\text{web}) = (As_3^3 \cdot h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$As_3 = Astir_3 \cdot ns_3 = 157.0796$$

$$\text{No stirups, } ns_3 = 0.00$$

$$A_{sec} = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 555.55$$

$$f_{ce} = 20.00$$

From ((5.A.5), TBDY), TBDY: $cc = 0.002$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.00231479$$

$$sh_1 = 0.008$$

$$ft_1 = 666.66$$

$$fy_1 = 555.55$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$su_1 = 0.4 \cdot esu_{1,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esu_{1,nominal} = 0.08$,

For calculation of $esu_{1,nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_1 = fs = 555.55$$

$$\text{with } Es_1 = Es = 200000.00$$

$$y_2 = 0.00231479$$

$$sh_2 = 0.008$$

$$ft_2 = 666.66$$

$$fy_2 = 555.55$$

$$su_2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 1.00$$

$$su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,

For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $fsy_2 = fs_2 / 1.2$, from table 5.1, TBDY.

y_2, sh_2, ft_2, fy_2 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_2 = fs = 555.55$$

$$\text{with } Es_2 = Es = 200000.00$$

$$y_v = 0.00231479$$

$$sh_v = 0.008$$

$$ft_v = 666.66$$

$$fy_v = 555.55$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,

considering characteristic value $fsyv = fsv / 1.2$, from table 5.1, TBDY

For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
characteristic value $fsyv = fsv / 1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = fs = 555.55$$

$$\text{with } Es_v = Es = 200000.00$$

$$1 = Asl, \text{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.10765806$$

$$2 = Asl, \text{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.10765806$$

$$v = Asl, \text{mid} / (b \cdot d) \cdot (fsv / fc) = 0.02313704$$

and confined core properties:

$$b = 190.00$$

$d = 2927.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 20.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.14310722$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.14310722$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.0307555$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.07442258$
 $Mu = MRc (4.14) = 6.1366E+009$
 $u = su (4.1) = 1.1691922E-005$

 Calculation of ratio l_b/d

 Adequate Lap Length: $l_b/d \geq 1$

 Calculation of Mu_{2+}

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.1598028E-005$
 $Mu = 5.5677E+009$

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 : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0035$
 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)
 $psh,min = \text{Min}(psh,x, psh,y) = 0.00069813$
 Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x$ (column 1) = $(A_{s1}*h1/s_1)/A_c = 0.00083776$
 $h1 = 600.00$
 $A_{s1} = A_{stir1}*ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,x$ (column 2) = $(A_{s2}*h2/s_2)/A_c = 0.00083776$
 $h2 = 600.00$

$As_2 = Astir_2 * ns_2 = 157.0796$
No stirups, $ns_2 = 2.00$
 $ps_{3,x}(\text{web}) = (As_3 * h_3 / s_3) / Ac = 0.00188496$
 $h_3 = 1800.00$
 $As_3 = Astir_3 * ns_3 = 0.00$
No stirups, $ns_3 = 2.00$

 $psh_y = ps_{1,y} + ps_{2,y} + ps_{3,y} = 0.00069813$
 $ps_{1,y}(\text{column 1}) = (As_1 * h_1 / s_1) / Ac = 0.00034907$
 $h_1 = 250.00$
 $As_1 = Astir_1 * ns_1 = 157.0796$
No stirups, $ns_1 = 2.00$
 $ps_{2,y}(\text{column 2}) = (As_2 * h_2 / s_2) / Ac = 0.00034907$
 $h_2 = 250.00$
 $As_2 = Astir_2 * ns_2 = 157.0796$
No stirups, $ns_2 = 2.00$
 $ps_{3,y}(\text{web}) = (As_3 * h_3 / s_3) / Ac = 0.00$
 $h_3 = 250.00$
 $As_3 = Astir_3 * ns_3 = 157.0796$
No stirups, $ns_3 = 0.00$

 $Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fy_{we} = 555.55$
 $f_{ce} = 20.00$
From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y_1 = 0.00231479$
 $sh_1 = 0.008$
 $ft_1 = 666.66$
 $fy_1 = 555.55$
 $su_1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$lo/lou, \min = lb/ld = 1.00$

$su_1 = 0.4 * esu_{1,nominal}((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu_{1,nominal} = 0.08$,

For calculation of $esu_{1,nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_1 = fs = 555.55$

with $Es_1 = Es = 200000.00$

$y_2 = 0.00231479$
 $sh_2 = 0.008$
 $ft_2 = 666.66$
 $fy_2 = 555.55$
 $su_2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$lo/lou, \min = lb/lb, \min = 1.00$

$su_2 = 0.4 * esu_{2,nominal}((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,

For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $fsy_2 = fs_2 / 1.2$, from table 5.1, TBDY.

y_2, sh_2, ft_2, fy_2 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_2 = fs = 555.55$

with $Es_2 = Es = 200000.00$

$y_v = 0.00231479$
 $sh_v = 0.008$
 $ft_v = 666.66$
 $fy_v = 555.55$
 $suv = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lo_{u,min} = lb/d = 1.00

su_v = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fs_{yv} = 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_{yv} = 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 = 555.55

with Es_v = Es = 200000.00

1 = Asl_{ten}/(b*d)*(fs₁/fc) = 0.10765806

2 = Asl_{com}/(b*d)*(fs₂/fc) = 0.10765806

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) = 0.14310722

2 = Asl_{com}/(b*d)*(fs₂/fc) = 0.14310722

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) = 0.06692943

Mu = MRc (4.14) = 5.5677E+009

u = su (4.1) = 1.1598028E-005

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu₂-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 1.1691922E-005

Mu = 6.1366E+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

sh₁ = 150.00

bo₁ = 190.00

ho₁ = 540.00

bi_{2,1} = 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

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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*ns1 = 157.0796

No stirrups, ns1 = 2.00

ps2,x (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00083776$

h2 = 600.00

As2 = Astir2*ns2 = 157.0796

No stirrups, ns2 = 2.00

ps3,x (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00188496$

h3 = 1800.00

As3 = Astir3*ns3 = 0.00

No stirrups, 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*ns1 = 157.0796

No stirrups, ns1 = 2.00

ps2,y (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00034907$

h2 = 250.00

As2 = Astir2*ns2 = 157.0796

No stirrups, ns2 = 2.00

ps3,y (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00$

h3 = 250.00

As3 = Astir3*ns3 = 157.0796

No stirrups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 555.55

fce = 20.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00231479

sh1 = 0.008

ft1 = 666.66

fy1 = 555.55

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/l_d = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 555.55

with Es1 = Es = 200000.00

y2 = 0.00231479

sh2 = 0.008

ft2 = 666.66

fy2 = 555.55

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 555.55

with Es2 = Es = 200000.00

yv = 0.00231479

shv = 0.008

ftv = 666.66

fyv = 555.55

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

lo/lou,min = lb/ld = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = fs = 555.55

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.10765806

2 = Asl,com/(b*d)*(fs2/fc) = 0.10765806

v = Asl,mid/(b*d)*(fsv/fc) = 0.02313704

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) = 0.14310722

2 = Asl,com/(b*d)*(fs2/fc) = 0.14310722

v = Asl,mid/(b*d)*(fsv/fc) = 0.0307555

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

v < vs,y2 - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.07442258

Mu = MRc (4.14) = 6.1366E+009

u = su (4.1) = 1.1691922E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.6794E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.6794E+006

From (22.5.1.1) and 11.5.4.3, ACI 318-14: Vr1 = 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)
 $f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 250.00$
 $d = 2400.00$
 $l_w = 3000.00$
 $\mu_u = 3.2196245E-010$
 $V_u = 6.3108872E-029$
 $N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 949449.618$

$V_{s1} = 223399.91$ is calculated for pseudo-Column 1, with:

$d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 444.44$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 223399.91$ is calculated for pseudo-Column 2, with:

$d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 444.44$

V_{s2} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s3} = 502649.798$ is calculated for web, with:

$d = 1440.00$
 $A_v = 157079.633$
 $s = 200.00$
 $f_y = 444.44$

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, $V_{r2} = 1.6794E+006$

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: $V_c = 729988.83$

$\mu_u / V_u - l_w / 2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 20.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 250.00$
 $d = 2400.00$
 $l_w = 3000.00$
 $\mu_u = 3.2196245E-010$
 $V_u = 6.3108872E-029$
 $N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 949449.618$

$V_{s1} = 223399.91$ is calculated for pseudo-Column 1, with:

$d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 444.44$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 223399.91$ is calculated for pseudo-Column 2, with:

$d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 444.44$

V_{s2} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s3} = 502649.798$ is calculated for web, with:

$d = 1440.00$
 $A_v = 157079.633$
 $s = 200.00$
 $f_y = 444.44$

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: rcrcws

Constant Properties

Knowledge Factor, $\phi = 0.85$
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 16.00$
Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 400.00$
Concrete Elasticity, $E_c = 21019.039$
Steel Elasticity, $E_s = 200000.00$

Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 500.00$

Total Height, $H_{tot} = 3000.00$
Edges Width, $W_{edg} = 250.00$
Edges Height, $H_{edg} = 600.00$
Web Width, $W_{web} = 250.00$
Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.00
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_o/l_{ou,min} > 1$)
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = 0.00$
EDGE -B-
Shear Force, $V_b = 0.00$
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: $As_{,ten} = 2368.761$
-Compression: $As_{,com} = 2368.761$
-Middle: $As_{,mid} = 0.00$
(According to 10.7.2.3 $As_{,mid}$ is setted equal to zero)

Calculation of Shear Capacity ratio, $V_e/V_r = 0.28750647$
Member Controlled by Flexure ($V_e/V_r < 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 211972.373$

with
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 3.1796E+008$
 $Mu_{1+} = 2.4327E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
 $Mu_{1-} = 3.1796E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 3.1796E+008$
 $Mu_{2+} = 2.4327E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
 $Mu_{2-} = 3.1796E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

Calculation of Mu_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$\phi_u = 0.00019144$
 $M_u = 2.4327E+008$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $f_c = 16.00$
 ϕ_c (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: $\phi_u = 0.0035$
 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)
 $p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$
Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$
 $p_{s1,x}$ (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 stirrups, $n_{s1} = 2.00$
 $p_{s2,x}$ (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 stirrups, $n_{s2} = 2.00$
 $p_{s3,x}$ (web) = $(A_{s3} * h_3 / s_3) / A_c = 0.00188496$
 $h_3 = 1800.00$
 $A_{s3} = A_{stir3} * n_{s3} = 0.00$
No stirrups, $n_{s3} = 2.00$

 $p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$
 $p_{s1,y}$ (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 (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 = 500.00
fce = 16.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00208333
sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value 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 = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 500.00
with Es2 = Es = 200000.00
yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 500.00

with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.11862785$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.11862785$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.00$
and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 16.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.14145031$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.14145031$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.00$
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)

--->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied
--->
 $su (4.9) = 0.18965884$
 $Mu = MRc (4.14) = 2.4327E+008$
 $u = su (4.1) = 0.00019144$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of Mu_1 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 0.00019712$
 $Mu = 3.1796E+008$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $f_c = 16.00$
 $co (5A.5, TBDY) = 0.002$
Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0035$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $cu = 0.0035$
we (5.4c) = 0.00
 $ase ((5.4d), TBDY) = (ase1*A_{col1} + ase2*A_{col2} + ase3*A_{web})/A_{sec} = 0.00$
 $ase1 = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $ase2 = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $ase3 = 0$ (grid does not provide confinement)
 $psh,min = \text{Min}(psh,x, psh,y) = 0.00069813$
Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$

ps1,x (column 1) = $(As1 \cdot h1 / s_1) / Ac = 0.00083776$
h1 = 600.00
As1 = Astir1 * 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 * ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,x (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00188496$
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) = $(As1 \cdot h1 / s_1) / Ac = 0.00034907$
h1 = 250.00
As1 = Astir1 * 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 * ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,y (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00$
h3 = 250.00
As3 = Astir3 * ns3 = 157.0796
No stirups, ns3 = 0.00

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00

fywe = 500.00
fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00

y1 = 0.00208333
sh1 = 0.00805

ft1 = 600.00
fy1 = 500.00

su1 = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

su1 = $0.4 \cdot esu1_nominal$ ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

y2 = 0.00208333

sh2 = 0.00805

ft2 = 600.00

fy2 = 500.00

su2 = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = $0.4 \cdot esu2_nominal$ ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 500.00

with Es2 = Es = 200000.00

$yv = 0.00208333$
 $shv = 0.00805$
 $ftv = 600.00$
 $fyv = 500.00$
 $suv = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/d = 1.00$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv,ftv,fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 500.00$
 with $Esv = Es = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.08055366$

and confined core properties:

$b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $fcc (5A.2, TBDY) = 16.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.09605114$

Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)

--->
 $v < vs,c$ - RHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.2130262$
 $Mu = MRc (4.14) = 3.1796E+008$
 $u = su (4.1) = 0.00019712$

 Calculation of ratio lb/d

 Adequate Lap Length: $lb/d \geq 1$

 Calculation of Mu_{2+}

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 0.00019144$
 $Mu = 2.4327E+008$

 with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $fc = 16.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = shear_factor * Max(cu, cc) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0035$
 $we (5.4c) = 0.00$
 $ase ((5.4d), TBDY) = (ase1*Acol1 + ase2*Acol2 + ase3*Aweb)/Asec = 0.00$

ase1 = 0.00
sh_1 = 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

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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*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*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,x (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00188496$
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) = $(As1 \cdot h1 / s_1) / Ac = 0.00034907$
h1 = 250.00
As1 = Astir1*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*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,y (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00$
h3 = 250.00
As3 = Astir3*ns3 = 157.0796
No stirups, ns3 = 0.00

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00

fywe = 500.00

fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00208333

sh1 = 0.00805

ft1 = 600.00

fy1 = 500.00

su1 = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

su1 = $0.4 \cdot esu1_nominal$ ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

$y_2 = 0.00208333$
 $sh_2 = 0.00805$
 $ft_2 = 600.00$
 $fy_2 = 500.00$
 $su_2 = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lo_{u,min} = lb/lb_{u,min} = 1.00$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08066667$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 500.00$
 with $Es_2 = Es = 200000.00$

$y_v = 0.00208333$
 $sh_v = 0.00805$
 $ft_v = 600.00$
 $fy_v = 500.00$
 $suv = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lo_{u,min} = lb/ld = 1.00$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08066667$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and 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 $fsv = fs = 500.00$
 with $Esv = Es = 200000.00$

$1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.11862785$
 $2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.11862785$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.00$

and confined core properties:

$b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $fcc (5A.2, TBDY) = 16.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.14145031$
 $2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.14145031$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.00$

Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)

--->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.18965884$
 $Mu = MRc (4.14) = 2.4327E+008$
 $u = su (4.1) = 0.00019144$

Calculation of ratio lb/ld

Adequate Lap Length: $lb/ld \geq 1$

Calculation of Mu_2

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 0.00019712
Mu = 3.1796E+008

with full section properties:

b = 3000.00
d = 208.00
d' = 42.00
v = 0.00275581
N = 27514.027
fc = 16.00
co (5A.5, TBDY) = 0.002
Final value of cu: $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0035$
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 = $\text{Min}(psh,x, psh,y) = 0.00069813$
Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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 stirrups, ns1 = 2.00
ps2,x (column 2) = $(As2 * h2 / s_2) / Ac = 0.00083776$
h2 = 600.00
As2 = $Astir2 * ns2 = 157.0796$
No stirrups, ns2 = 2.00
ps3,x (web) = $(As3 * h3 / s_3) / Ac = 0.00188496$
h3 = 1800.00
As3 = $Astir3 * ns3 = 0.00$
No stirrups, 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 stirrups, ns1 = 2.00
ps2,y (column 2) = $(As2 * h2 / s_2) / Ac = 0.00034907$
h2 = 250.00
As2 = $Astir2 * ns2 = 157.0796$
No stirrups, ns2 = 2.00
ps3,y (web) = $(As3 * h3 / s_3) / Ac = 0.00$
h3 = 250.00
As3 = $Astir3 * ns3 = 157.0796$
No stirrups, ns3 = 0.00

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 500.00
fce = 16.00
From ((5.A5), TBDY), TBDY: $cc = 0.002$
c = confinement factor = 1.00

$y1 = 0.00208333$
 $sh1 = 0.00805$
 $ft1 = 600.00$
 $fy1 = 500.00$
 $su1 = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/d = 1.00$
 $su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,
 For calculation of $esu1_nominal$ and $y1, sh1,ft1,fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, 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 $fs1 = fs = 500.00$
 with $Es1 = Es = 200000.00$

$y2 = 0.00208333$
 $sh2 = 0.00805$
 $ft2 = 600.00$
 $fy2 = 500.00$
 $su2 = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/lb,min = 1.00$
 $su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esu2_nominal = 0.08066667$,
 For calculation of $esu2_nominal$ and $y2, sh2,ft2,fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = fs = 500.00$
 with $Es2 = Es = 200000.00$

$yv = 0.00208333$
 $shv = 0.00805$
 $ftv = 600.00$
 $fyv = 500.00$
 $suv = 0.03226667$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/d = 1.00$
 $suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv,ftv,fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 500.00$
 with $Esv = Es = 200000.00$

$1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.08055366$

and confined core properties:

$b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $fcc (5A.2, TBDY) = 16.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.09605114$

Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)

---->
 $v < vs,c$ - RHS eq.(4.5) is satisfied
 ---->

su (4.9) = 0.2130262
Mu = MRc (4.14) = 3.1796E+008
u = su (4.1) = 0.00019712

Calculation of ratio lb/l_d

Adequate Lap Length: lb/l_d >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 737278.61

Calculation of Shear Strength at edge 1, Vr1 = 737278.61
From (22.5.1.1) and 11.5.4.3, ACI 318-14: Vr1 = 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 = 653502.805
Mu/Vu-lw/2 = 0.00 <= 0
= 1 (normal-weight concrete)
fc' = 16.00, but fc'^{0.5} <= 8.3 MPa (22.5.3.1, ACI 318-14)
h = 3000.00
d = 200.00
lw = 250.00
Mu = 1.4551920E-011
Vu = 0.00
Nu = 27514.027
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 + Vs3 = 83775.804
Vs1 = 41887.902 is calculated for pseudo-Column 1, with:
d = 200.00
Av = 157079.633
s = 150.00
fy = 400.00
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 = 41887.902 is calculated for pseudo-Column 2, with:
d = 200.00
Av = 157079.633
s = 150.00
fy = 400.00
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 = 400.00
Vs3 has been multiplied by 2(1-s/d) (s>d/2, according to ASCE 41-17,10.3.4)
2(1-s/d) = 0.00
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 1.5943E+006
bw = 3000.00

Calculation of Shear Strength at edge 2, Vr2 = 737278.61
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 = 653502.805
Mu/Vu-lw/2 = 0.00 <= 0
= 1 (normal-weight concrete)
fc' = 16.00, but fc'^{0.5} <= 8.3 MPa (22.5.3.1, ACI 318-14)
h = 3000.00

d = 200.00
lw = 250.00
Mu = 1.4551920E-011
Vu = 0.00
Nu = 27514.027

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

$V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

d = 200.00
Av = 157079.633
s = 150.00
fy = 400.00

V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

d = 200.00
Av = 157079.633
s = 150.00
fy = 400.00

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
Av = 0.00
s = 200.00
fy = 400.00

V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$

bw = 3000.00

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcrws

Constant Properties

Knowledge Factor, $\phi = 0.85$
According to 10.7.2.3, ASCE 41-17, shear walls with
transverse reinforcement percentage, $\rho_t < 0.0015$
are considered Force-Controlled and lower-bound strengths are used according to 7.5.1.3, ASCE 41-17
 $n = 0.00069813$

with $n = \rho_{s1} + \rho_{s2} + \rho_{s3}$, being the shear reinf. ratio in a plane perpendicular to the shear axis 3

(pseudo-col.1 $\rho_{s1} = A_{s1} \cdot b_1 / s_1 = (A_{s1} \cdot h_1 / s_1) / A_c = 0.00034907$

h1 = 250.00

s1 = 150.00

total area of hoops perpendicular to shear axis, $A_{s1} = 157.0796$

(pseudo-col.2 $\rho_{s2} = A_{s2} \cdot b_2 / s_2 = (A_{s2} \cdot h_2 / s_2) / A_c = 0.00034907$

h2 = 250.00

s2 = 150.00

total area of hoops perpendicular to shear axis, $A_{s2} = 157.0796$

(grid $\rho_{s3} = A_{s3} \cdot b_3 / s_3 = (A_{s3} \cdot h_3 / s_3) / A_c = 0.00$

h3 = 250.00

s3 = 200.00

total area of hoops perpendicular to shear axis, $A_{s3} = 0.00$

total section area, $A_c = 750000.00$

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$
Concrete Elasticity, $E_c = 21019.039$
Steel Elasticity, $E_s = 200000.00$
Total Height, $H_{tot} = 3000.00$
Edges Width, $W_{edg} = 250.00$
Edges Height, $H_{edg} = 600.00$
Web Width, $W_{web} = 250.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_b/l_d >= 1$)
No FRP Wrapping

Stepwise Properties

Axial Force, $F = -29778.709$
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, $Db_L = 17.33333$

Considering wall controlled by Shear (shear control ratio > 1),
interstorey drift provided values are calculated
Existing component: From table 7-7, ASCE 41_17: Final interstorey drift Capacity $u_{,R} = * u = 0.015$
from table 10-20: $u = 0.01764706$

with:

- Condition i (shear wall and wall segments)
- $(As - As') * f_y + P) / (tw * lw * f_c') = -0.20905235$
 $As = 0.00$
 $As' = 6346.017$
 $f_y = 400.00$
 $P = 29778.709$
 $tw = 250.00$
 $lw = 3000.00$
 $f_c = 16.00$

End Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 15

wall W1, Floor 1

Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (d)

Section Type: rcrws

Constant Properties

Knowledge Factor, $\gamma = 0.85$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{o,min} = l_b/d \geq 1$)

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 1.0288E+008$

Shear Force, $V_a = -34425.832$

EDGE -B-

Bending Moment, $M_b = 419898.816$

Shear Force, $V_b = 34425.832$

BOTH EDGES

Axial Force, $F = -29778.709$

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, $Db_{L,ten} = 17.33333$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = *V_n = 1.2822E+006$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83*fc'^{0.5}*h*d = 1.5085E+006$

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: $V_c = 653955.742$

$M_u/V_u - l_w/2 = -1487.803 <= 0$

= 1 (normal-weight concrete)

$fc' = 16.00$, but $fc'^{0.5} <= 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$M_u = 419898.816$

$V_u = 34425.832$

$N_u = 29778.709$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$

$V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

V_{s2} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s3} = 452389.342$ is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 400.00$

V_{s3} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

V_f ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f <= 1.5943E+006$

$b_w = 250.00$

End Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (d)

Calculation No. 16

wall W1, Floor 1

Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (θ_r)

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: rcw

Constant Properties

Knowledge Factor, $\gamma = 0.85$

Mean strength values are used for both shear and moment calculations.

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 555.55$

#####

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, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou, min} \geq 1$)

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = -6.3108872E-029$

EDGE -B-

Shear Force, $V_b = 6.3108872E-029$

BOTH EDGES

Axial Force, $F = -27514.027$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 0.00$

-Compression: $As_c = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 2865.133$

-Compression: $As_{l,com} = 2865.133$

-Middle: $As_{l,mid} = 0.00$

(According to 10.7.2.3 $As_{l,mid}$ is setted equal to zero)

Calculation of Shear Capacity ratio, $V_e/V_r = 2.43595$

Member Controlled by Shear ($V_e/V_r > 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 4.0910E+006$

with

$M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 6.1366E+009$

$Mu_{1+} = 5.5677E+009$, 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

$Mu_{1-} = 6.1366E+009$, 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

$M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 6.1366E+009$

$Mu_{2+} = 5.5677E+009$, 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

$Mu_{2-} = 6.1366E+009$, 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:

$\phi_u = 1.1598028E-005$

$M_u = 5.5677E+009$

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$

$v = 0.00186094$

$N = 27514.027$

$f_c = 20.00$

α_1 (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0035$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\phi_{cu} = 0.0035$

we (5.4c) = 0.00

$\alpha_{se}((5.4d), \text{TBDY}) = (\alpha_{se1} * A_{col1} + \alpha_{se2} * A_{col2} + \alpha_{se3} * A_{web}) / A_{sec} = 0.00$

$\alpha_{se1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$\alpha_{se2} = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$\alpha_{se3} = 0$ (grid does not provide confinement)

$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $\phi_{psh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without

earthquake detailing (90° closed stirrups)

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 = 555.55

fce = 20.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00231479

sh1 = 0.008

ft1 = 666.66

fy1 = 555.55

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.

with fs1 = fs = 555.55

with Es1 = Es = 200000.00

y2 = 0.00231479

sh2 = 0.008

ft2 = 666.66

fy2 = 555.55

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_2 = fs = 555.55$

with $Es_2 = Es = 200000.00$

$yv = 0.00231479$

$shv = 0.008$

$ftv = 666.66$

$fyv = 555.55$

$suv = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$lo/lou, \text{min} = lb/d = 1.00$

$suv = 0.4 \cdot esuv_{\text{nominal}} ((5.5), \text{TBDY}) = 0.032$

From table 5A.1, TBDY: $esuv_{\text{nominal}} = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_{\text{nominal}}$ and yv, shv, ftv, fyv , it is considered

characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fsv = fs = 555.55$

with $Es_v = Es = 200000.00$

1 = $Asl, \text{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.10765806$

2 = $Asl, \text{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.10765806$

$v = Asl, \text{mid} / (b \cdot d) \cdot (fsv / fc) = 0.00$

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 = $Asl, \text{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.14310722$

2 = $Asl, \text{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.14310722$

$v = Asl, \text{mid} / (b \cdot d) \cdot (fsv / fc) = 0.00$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < vs, y_2$ - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.06692943

$Mu = MRc$ (4.14) = 5.5677E+009

$u = su$ (4.1) = 1.1598028E-005

Calculation of ratio lb/d

Adequate Lap Length: $lb/d \geq 1$

Calculation of Mu_1 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 1.1691922E-005$

$Mu = 6.1366E+009$

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 : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.0035$

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) = $(ase1 \cdot Acol1 + ase2 \cdot Acol2 + ase3 \cdot Aweb) / Asec = 0.00$

$ase1 = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$ase2 = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$ase3 = 0$ (grid does not provide confinement)

$psh,min = \text{Min}(psh,x, psh,y) = 0.00069813$

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$

$ps1,x$ (column 1) = $(As1 \cdot h1 / s_1) / Ac = 0.00083776$

$h1 = 600.00$

$As1 = Astir1 \cdot ns1 = 157.0796$

No stirrups, $ns1 = 2.00$

$ps2,x$ (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00083776$

$h2 = 600.00$

$As2 = Astir2 \cdot ns2 = 157.0796$

No stirrups, $ns2 = 2.00$

$ps3,x$ (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00188496$

$h3 = 1800.00$

$As3 = Astir3 \cdot ns3 = 0.00$

No stirrups, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$

$ps1,y$ (column 1) = $(As1 \cdot h1 / s_1) / Ac = 0.00034907$

$h1 = 250.00$

$As1 = Astir1 \cdot ns1 = 157.0796$

No stirrups, $ns1 = 2.00$

$ps2,y$ (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00034907$

$h2 = 250.00$

$As2 = Astir2 \cdot ns2 = 157.0796$

No stirrups, $ns2 = 2.00$

$ps3,y$ (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00$

$h3 = 250.00$

$As3 = Astir3 \cdot ns3 = 157.0796$

No stirrups, $ns3 = 0.00$

$Asec = 750000.00$

$s_1 = 150.00$

$s_2 = 150.00$

$s_3 = 200.00$

$fywe = 555.55$

$fce = 20.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$

$c =$ confinement factor = 1.00

$y1 = 0.00231479$

$sh1 = 0.008$

$ft1 = 666.66$

$fy1 = 555.55$

$su1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$lo/lou,min = lb/ld = 1.00$

$su1 = 0.4 \cdot esu1_nominal$ ((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.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_1 = fs = 555.55$

with $Es_1 = Es = 200000.00$

$y_2 = 0.00231479$

$sh_2 = 0.008$

$ft_2 = 666.66$

$fy_2 = 555.55$

$su_2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$lo/lou, min = lb/lb, min = 1.00$

$su_2 = 0.4 \cdot esu_{2, nominal} ((5.5), TBDY) = 0.032$

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 $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_2 = fs = 555.55$

with $Es_2 = Es = 200000.00$

$y_v = 0.00231479$

$sh_v = 0.008$

$ft_v = 666.66$

$fy_v = 555.55$

$su_v = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$lo/lou, min = lb/d = 1.00$

$su_v = 0.4 \cdot esu_{v, nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu_{v, nominal} = 0.08$,

considering characteristic value $fsy_v = fs_v/1.2$, from table 5.1, TBDY

For calculation of $esu_{v, nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered characteristic value $fsy_v = fs_v/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_v = fs = 555.55$

with $Es_v = Es = 200000.00$

$1 = Asl, ten / (b \cdot d) \cdot (fs_1 / fc) = 0.10765806$

$2 = Asl, com / (b \cdot d) \cdot (fs_2 / fc) = 0.10765806$

$v = Asl, mid / (b \cdot d) \cdot (fs_v / fc) = 0.02313704$

and confined core properties:

$b = 190.00$

$d = 2927.00$

$d' = 13.00$

$f_{cc} (5A.2, TBDY) = 20.00$

$cc (5A.5, TBDY) = 0.002$

$c = \text{confinement factor} = 1.00$

$1 = Asl, ten / (b \cdot d) \cdot (fs_1 / fc) = 0.14310722$

$2 = Asl, com / (b \cdot d) \cdot (fs_2 / fc) = 0.14310722$

$v = Asl, mid / (b \cdot d) \cdot (fs_v / fc) = 0.0307555$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s, y_2}$ - LHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.07442258$

$Mu = MRc (4.14) = 6.1366E+009$

$u = su (4.1) = 1.1691922E-005$

Calculation of ratio lb/d

Adequate Lap Length: $lb/d \geq 1$

Calculation of Mu_{2+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 1.1598028E-005$$

$$\mu = 5.5677E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00186094$$

$$N = 27514.027$$

$$f_c = 20.00$$

$$c_o(5A.5, TBDY) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0035$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.0035$$

$$w_e(5.4c) = 0.00$$

$$a_{se}((5.4d), TBDY) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$$

$$p_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$p_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$p_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirrups, } n_{s3} = 2.00$$

$$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$$

$$p_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$p_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$p_{s3,y} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

$$\text{No stirrups, } n_{s3} = 0.00$$

$$A_{sec} = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 555.55$$

fce = 20.00

From ((5.A.5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00231479

sh1 = 0.008

ft1 = 666.66

fy1 = 555.55

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{d})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 555.55

with Es1 = Es = 200000.00

y2 = 0.00231479

sh2 = 0.008

ft2 = 666.66

fy2 = 555.55

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{d})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 555.55

with Es2 = Es = 200000.00

yv = 0.00231479

shv = 0.008

ftv = 666.66

fyv = 555.55

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{d})^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = fs = 555.55

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.10765806

2 = Asl,com/(b*d)*(fs2/fc) = 0.10765806

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) = 0.14310722

2 = Asl,com/(b*d)*(fs2/fc) = 0.14310722

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) = 0.06692943
Mu = MRc (4.14) = 5.5677E+009
u = su (4.1) = 1.1598028E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.1691922E-005
Mu = 6.1366E+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
Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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 = 555.55

fce = 20.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00231479

sh1 = 0.008

ft1 = 666.66

fy1 = 555.55

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.

with fs1 = fs = 555.55

with Es1 = Es = 200000.00

y2 = 0.00231479

sh2 = 0.008

ft2 = 666.66

fy2 = 555.55

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.

with fs2 = fs = 555.55

with Es2 = Es = 200000.00

yv = 0.00231479

shv = 0.008

ftv = 666.66

fyv = 555.55

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered

characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.

with fsv = fs = 555.55

with $E_{sv} = E_s = 200000.00$

$$1 = A_{s1,ten}/(b*d)*(f_{s1}/f_c) = 0.10765806$$

$$2 = A_{s1,com}/(b*d)*(f_{s2}/f_c) = 0.10765806$$

$$v = A_{s1,mid}/(b*d)*(f_{sv}/f_c) = 0.02313704$$

and confined core properties:

$$b = 190.00$$

$$d = 2927.00$$

$$d' = 13.00$$

$$f_{cc} \text{ (5A.2, TBDY)} = 20.00$$

$$c_c \text{ (5A.5, TBDY)} = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{s1,ten}/(b*d)*(f_{s1}/f_c) = 0.14310722$$

$$2 = A_{s1,com}/(b*d)*(f_{s2}/f_c) = 0.14310722$$

$$v = A_{s1,mid}/(b*d)*(f_{sv}/f_c) = 0.0307555$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u \text{ (4.9)} = 0.07442258$$

$$M_u = M_{Rc} \text{ (4.14)} = 6.1366E+009$$

$$u = s_u \text{ (4.1)} = 1.1691922E-005$$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 1.6794E+006$

Calculation of Shear Strength at edge 1, $V_{r1} = 1.6794E+006$

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 ' $V_w + f_v V_f$ '
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)

$$f_c' = 20.00, \text{ but } f_c'^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$h = 250.00$$

$$d = 2400.00$$

$$l_w = 3000.00$$

$$M_u = 3.2196245E-010$$

$$V_u = 6.3108872E-029$$

$$N_u = 27514.027$$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 949449.618$

$V_{s1} = 223399.91$ is calculated for pseudo-Column 1, with:

$$d = 480.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 444.44$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 223399.91$ is calculated for pseudo-Column 2, with:

$$d = 480.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 444.44$$

V_{s2} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s3} = 502649.798$ is calculated for web, with:

$$d = 1440.00$$

$$A_v = 157079.633$$

$$s = 200.00$$

$$f_y = 444.44$$

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 = 1.6794E+006
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 = 250.00
d = 2400.00
lw = 3000.00
Mu = 3.2196245E-010
Vu = 6.3108872E-029
Nu = 27514.027

From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 + Vs3 = 949449.618
Vs1 = 223399.91 is calculated for pseudo-Column 1, with:

d = 480.00
Av = 157079.633
s = 150.00
fy = 444.44

Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs2 = 223399.91 is calculated for pseudo-Column 2, with:

d = 480.00
Av = 157079.633
s = 150.00
fy = 444.44

Vs2 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs3 = 502649.798 is calculated for web, with:

d = 1440.00
Av = 157079.633
s = 200.00
fy = 444.44

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: rcwrs

Constant Properties

Knowledge Factor, = 0.85
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 16.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

#####

Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 500.00$

#####

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou, \min} \geq 1$)

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = 0.00$

EDGE -B-

Shear Force, $V_b = 0.00$

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 , $V_e/V_r = 0.28750647$

Member Controlled by Flexure ($V_e/V_r < 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 211972.373$

with

$M_{pr1} = \text{Max}(M_{u1+} , M_{u1-}) = 3.1796E+008$

$M_{u1+} = 2.4327E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$M_{u1-} = 3.1796E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

$M_{pr2} = \text{Max}(M_{u2+} , M_{u2-}) = 3.1796E+008$

$M_{u2+} = 2.4327E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

$M_{u2-} = 3.1796E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

Calculation of M_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$\phi_u = 0.00019144$

$M_u = 2.4327E+008$

with full section properties:

$b = 3000.00$

$d = 208.00$

$d' = 42.00$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

$$c_o (5A.5, TBDY) = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0035$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.0035$$

$$w_e (5.4c) = 0.00$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$$

$$p_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$p_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$p_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirrups, } n_{s3} = 2.00$$

$$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$$

$$p_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$p_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$p_{s3,y} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

$$\text{No stirrups, } n_{s3} = 0.00$$

$$A_{sec} = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$f_{ywe} = 500.00$$

$$f_{ce} = 16.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.00208333$$

$$sh_1 = 0.00805$$

$$ft_1 = 600.00$$

$$fy_1 = 500.00$$

$$su_1 = 0.03226667$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

y2 = 0.00208333

sh2 = 0.00805

ft2 = 600.00

fy2 = 500.00

su2 = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 500.00

with Es2 = Es = 200000.00

yv = 0.00208333

shv = 0.00805

ftv = 600.00

fyv = 500.00

suv = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/d = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esuv_nominal = 0.08066667,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = fs = 500.00

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785

2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785

v = Asl,mid/(b*d)*(fsv/fc) = 0.00

and confined core properties:

b = 2940.00

d = 178.00

d' = 12.00

fcc (5A.2, TBDY) = 16.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031

2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031

v = Asl,mid/(b*d)*(fsv/fc) = 0.00

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

v < vs,c - RHS eq.(4.5) is satisfied

--->

su (4.9) = 0.18965884

Mu = MRc (4.14) = 2.4327E+008

u = su (4.1) = 0.00019144

Calculation of ratio lb/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of μ_1 -

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\mu = 0.00019712$$

$$\mu_1 = 3.1796E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0035$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.0035$$

$$w_e \text{ (5.4c)} = 0.00$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi_{2,1} = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi_{2,2} = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$$

$$p_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$p_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$p_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirrups, } n_{s3} = 2.00$$

$$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$$

$$p_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$p_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$p_{s3,y} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00$$

$$h_3 = 250.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 157.0796$$

$$\text{No stirrups, } n_{s3} = 0.00$$

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 500.00

fce = 16.00

From ((5.A.5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00208333

sh1 = 0.00805

ft1 = 600.00

fy1 = 500.00

su1 = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

y2 = 0.00208333

sh2 = 0.00805

ft2 = 600.00

fy2 = 500.00

su2 = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 500.00

with Es2 = Es = 200000.00

yv = 0.00208333

shv = 0.00805

ftv = 600.00

fyv = 500.00

suv = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esuv_nominal = 0.08066667,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = fs = 500.00

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785

2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785

v = Asl,mid/(b*d)*(fsv/fc) = 0.08055366

and confined core properties:

b = 2940.00

d = 178.00

d' = 12.00

fcc (5A.2, TBDY) = 16.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

1 = $Asl,ten/(b*d)*(fs1/fc) = 0.14145031$

2 = $Asl,com/(b*d)*(fs2/fc) = 0.14145031$

v = $Asl,mid/(b*d)*(fsv/fc) = 0.09605114$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

v < vs,c - RHS eq.(4.5) is satisfied

su (4.9) = 0.2130262

Mu = MRc (4.14) = 3.1796E+008

u = su (4.1) = 0.00019712

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 0.00019144

Mu = 2.4327E+008

with full section properties:

b = 3000.00

d = 208.00

d' = 42.00

v = 0.00275581

N = 27514.027

fc = 16.00

co (5A.5, TBDY) = 0.002

Final value of cu: $cu^* = shear_factor * Max(cu, cc) = 0.0035$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.0035

we (5.4c) = 0.00

ase ((5.4d), TBDY) = $(ase1*Acol1+ase2*Acol2+ase3*Aweb)/Asec = 0.00$

ase1 = 0.00

sh_1 = 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

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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 stirrups, ns1 = 2.00

ps2,x (column 2) = $(As2*h2/s_2)/Ac = 0.00083776$

h2 = 600.00

As2 = Astir2*ns2 = 157.0796

No stirrups, 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 = 500.00
fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00

y1 = 0.00208333
sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 1.00

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 500.00

with Es1 = Es = 200000.00

y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 500.00

with Es2 = Es = 200000.00

yv = 0.00208333
shv = 0.00805
ftv = 600.00
fyv = 500.00
suv = 0.03226667

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 1.00

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
 considering characteristic value $fsv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv,ftv,fyv , it is considered
 characteristic value $fsv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 500.00$
 with $Esv = Es = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.11862785$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.11862785$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00$

and confined core properties:

$b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 fcc (5A.2, TBDY) = 16.00
 cc (5A.5, TBDY) = 0.002
 $c =$ confinement factor = 1.00
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.14145031$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.14145031$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00$

Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)

---->
 $v < vs,c$ - RHS eq.(4.5) is satisfied
 ---->
 su (4.9) = 0.18965884
 $Mu = MRc$ (4.14) = 2.4327E+008
 $u = su$ (4.1) = 0.00019144

 Calculation of ratio lb/d

 Adequate Lap Length: $lb/d \geq 1$

 Calculation of $Mu2$ -

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 0.00019712$
 $Mu = 3.1796E+008$

 with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $fc = 16.00$
 co (5A.5, TBDY) = 0.002
 Final value of cu : $cu^* = shear_factor * Max(cu, cc) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0035$
 we (5.4c) = 0.00
 ase ((5.4d), TBDY) = $(ase1*Acol1 + ase2*Acol2 + ase3*Aweb)/Asec = 0.00$
 $ase1 = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $ase2 = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$

ase3 = 0 (grid does not provide confinement)
psh,min = Min(psh,x , psh,y) = 0.00069813
Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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 = 500.00
fce = 16.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00208333
sh1 = 0.00805
ft1 = 600.00
fy1 = 500.00
su1 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 500.00
with Es1 = Es = 200000.00
y2 = 0.00208333
sh2 = 0.00805
ft2 = 600.00
fy2 = 500.00
su2 = 0.03226667
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: $esu2_nominal = 0.08066667$,

For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs2 = fs = 500.00$

with $Es2 = Es = 200000.00$

$yv = 0.00208333$

$shv = 0.00805$

$ftv = 600.00$

$fyv = 500.00$

$suv = 0.03226667$

using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$

and also multiplied by the $shear_factor$ according to 15.7.1.4, with

$Shear_factor = 1.00$

$lo/lo_{u,min} = lb/d = 1.00$

$suv = 0.4 \cdot esuv_nominal$ ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered

characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fsv = fs = 500.00$

with $Es_v = Es = 200000.00$

$1 = Asl_{ten}/(b \cdot d) \cdot (fs1/fc) = 0.11862785$

$2 = Asl_{com}/(b \cdot d) \cdot (fs2/fc) = 0.11862785$

$v = Asl_{mid}/(b \cdot d) \cdot (fsv/fc) = 0.08055366$

and confined core properties:

$b = 2940.00$

$d = 178.00$

$d' = 12.00$

f_{cc} (5A.2, TBDY) = 16.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

$1 = Asl_{ten}/(b \cdot d) \cdot (fs1/fc) = 0.14145031$

$2 = Asl_{com}/(b \cdot d) \cdot (fs2/fc) = 0.14145031$

$v = Asl_{mid}/(b \cdot d) \cdot (fsv/fc) = 0.09605114$

Case/Assumption: Unconfined full section - Steel rupture

' does not satisfy Eq. (4.3)

--->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

--->

su (4.9) = 0.2130262

$Mu = MRc$ (4.14) = $3.1796E+008$

$u = su$ (4.1) = 0.00019712

Calculation of ratio lb/d

Adequate Lap Length: $lb/d \geq 1$

Calculation of Shear Strength $Vr = \text{Min}(Vr1, Vr2) = 737278.61$

Calculation of Shear Strength at edge 1, $Vr1 = 737278.61$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $Vr1 = Vn < 0.83 \cdot fc'^{0.5} \cdot h \cdot d$

NOTE: In expression (22.5.1.1) ' Vw ' is replaced by ' $Vw + f \cdot Vf$ '

where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (11.5.4.6(d-e)), ACI 318-14: $Vc = 653502.805$

$Mu/Vu - lw/2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$fc' = 16.00$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

lw = 250.00
Mu = 1.4551920E-011
Vu = 0.00
Nu = 27514.027

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

$V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

d = 200.00
Av = 157079.633
s = 150.00
fy = 400.00

V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

d = 200.00
Av = 157079.633
s = 150.00
fy = 400.00

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
Av = 0.00
s = 200.00
fy = 400.00

V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$

bw = 3000.00

Calculation of Shear Strength at edge 2, $V_{r2} = 737278.61$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r2} = V_n < 0.83 \cdot f_c' \cdot h \cdot d$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$M_u/V_u - l_w/2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

h = 3000.00

d = 200.00

lw = 250.00

Mu = 1.4551920E-011

Vu = 0.00

Nu = 27514.027

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

$V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

d = 200.00
Av = 157079.633
s = 150.00
fy = 400.00

V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

d = 200.00
Av = 157079.633
s = 150.00
fy = 400.00

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
Av = 0.00
s = 200.00
fy = 400.00

V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$
 $V_f((11-3)-(11.4), \text{ACI 440}) = 0.00$
From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$
 $bw = 3000.00$

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1
At local axis: 3
Integration Section: (d)
Section Type: rcrws

Constant Properties

Knowledge Factor, $\phi = 0.85$
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 $n = ps_1 + ps_2 + ps_3$, being the shear reinf. ratio in a plane perpendicular to the shear axis 2
(pseudo-col.1 $ps_1 = A_{s1} \cdot b_1 / s_1 = (A_{s1} \cdot h_1 / s_1) / A_c = 0.00034907$
 $h_1 = 250.00$
 $s_1 = 150.00$
total area of hoops perpendicular to shear axis, $A_{s1} = 157.0796$
(pseudo-col.2 $ps_2 = A_{s2} \cdot b_2 / s_2 = (A_{s2} \cdot h_2 / s_2) / A_c = 0.00034907$
 $h_2 = 250.00$
 $s_2 = 150.00$
total area of hoops perpendicular to shear axis, $A_{s2} = 157.0796$
(grid $ps_3 = A_{s3} \cdot b_3 / s_3 = (A_{s3} \cdot h_3 / s_3) / A_c = 0.00$
 $h_3 = 250.00$
 $s_3 = 200.00$
total area of hoops perpendicular to shear axis, $A_{s3} = 0.00$
total section area, $A_c = 750000.00$

Consequently:
Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$
Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$
Concrete Elasticity, $E_c = 21019.039$
Steel Elasticity, $E_s = 200000.00$
Total Height, $H_{tot} = 3000.00$
Edges Width, $W_{edg} = 250.00$
Edges Height, $H_{edg} = 600.00$
Web Width, $W_{web} = 250.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_b/d \geq 1$)
No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 1.1776172E-010$
Shear Force, $V_2 = -7.3960296E-015$
Shear Force, $V_3 = 34425.832$
Axial Force, $F = -29778.709$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 0.00$

-Compression: $As_c = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{ten} = 2368.761$

-Compression: $As_{com} = 2368.761$

-Middle: $As_{mid} = 1608.495$

Mean Diameter of Tension Reinforcement, $Db_L = 17.20$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_{R} = \rho \cdot u = 0.00838092$

$u = \rho \cdot y + p = 0.0098599$

- Calculation of y -

$y = (M_y \cdot I_p) / (EI)_{Eff} = 0.0018599$ ((10-5), ASCE 41-17))

$M_y = 2.2270E+008$

$(EI)_{Eff} = 0.35 \cdot E_c \cdot I$ (table 10-5)

$E_c \cdot I = 8.2106E+013$

$I_p = 0.5 \cdot d = 0.5 \cdot (0.8 \cdot h) = 240.00$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$

$y_{ten} = 1.2995450E-005$

with $f_y = 400.00$

$d = 208.00$

$y = 0.26009605$

$A = 0.01028921$

$B = 0.00623102$

with $p_t = 0.00379609$

$p_c = 0.00379609$

$p_v = 0.00257772$

$N = 29778.709$

$b = 3000.00$

" = 0.20192308

$y_{comp} = 2.5439724E-005$

with $f_c = 16.00$

$E_c = 21019.039$

$y = 0.25894283$

$A = 0.00999575$

$B = 0.00611172$

with $E_s = 200000.00$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

- Calculation of p -

Considering wall controlled by flexure (shear control ratio ≤ 1),

from table 10-19: $p = 0.008$

with:

- Condition i (shear wall and wall segments)

$-(A_s - A_s') \cdot f_y + P) / (t_w \cdot l_w \cdot f_c') = -0.20905235$

$A_s = 0.00$

$A_s' = 6346.017$

$f_y = 400.00$

$P = 29778.709$

$t_w = 3000.00$

$l_w = 250.00$

$f_c = 16.00$

- $V/(t_w \cdot l_w \cdot f_c^{0.5}) = 2.9689345E-020$, 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:

$V_{w1} = 83775.804$

$s_1 = 150.00$

Boundary Element 2:

$V_{w2} = 83775.804$

$s_2 = 150.00$

Grid Shear Force, $V_{w3} = 0.00$

Concrete Shear Force, $V_c = 123873.522$

(The variables above have already been given in Shear control ratio calculation)

Mean diameter of all bars, $d_b = 17.33333$

Design Shear Force, $V = 7.3960296E-015$

End Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (d)
