

Detailed Member Calculations

Units: N&mm

Regulation: ASCE 41-17

Calculation No. 1

beam B1, Floor 1

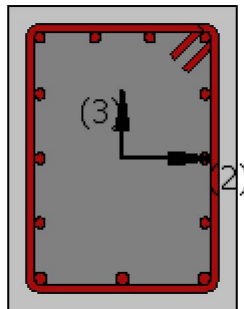
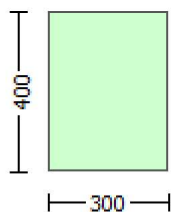
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VR_d

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: beam B1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

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

Consequently:

New material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$
Section Height, $H = 400.00$
Section Width, $W = 300.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 1850.00$
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_o = l_b = 300.00$
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, $M_a = -6.3267464E-011$
Shear Force, $V_a = -6.0183003E-014$
EDGE -B-
Bending Moment, $M_b = -4.8101563E-011$
Shear Force, $V_b = 6.0183003E-014$
BOTH EDGES
Axial Force, $F = -612.5536$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 911.0619$
-Compression: $A_{sc} = 1231.504$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten} = 816.8141$
-Compression: $A_{st,com} = 816.8141$
-Middle: $A_{st,mid} = 508.938$
Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 14.40$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 171047.78$
 V_n ((22.5.1.1), ACI 318-14) = 171047.78

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

From Table (22.5.5.1), ACI 318-14: $V_c = 76800.00$
= 1 (normal-weight concrete)
 $f'_c = 25.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00949023$
 A_s (tension reinf.) = 911.0619
 $b_w = 400.00$
 $d = 240.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 6.3267464E-011$
 $V_u = 6.0183003E-014$
From (11.5.4.8), ACI 318-14: $V_s = 94247.78$
 $A_v = 157079.633$
 $f_y = 500.00$
 $s = 150.00$
 V_s has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17, 10.3.4)
 $2(1-s/d) = 0.75$
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 318865.838$

End Of Calculation of Shear Capacity for element: beam B1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 2

beam B1, Floor 1

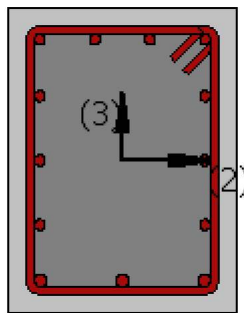
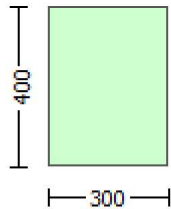
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (ϕ_r)

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

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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

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

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Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.06217

Element Length, $L = 1850.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = 300.00$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 2771.022$

EDGE -B-

Shear Force, $V_b = 2771.021$

BOTH EDGES

Axial Force, $F = -190.7537$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 911.0619$

-Compression: $As_c = 1231.504$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 911.0619$

-Compression: $As_{l,com} = 923.6282$

-Middle: $As_{l,mid} = 307.8761$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.39885187$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 115624.954$ with

$M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 1.0444E+008$

$Mu_{1+} = 1.0296E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$Mu_{1-} = 1.0444E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

$M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 1.0434E+008$

$Mu_{2+} = 1.0305E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination

$Mu_{2-} = 1.0434E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination

and

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

with

$V_1 = 2771.022$, is the shear force acting at edge 1 for the static loading combination

$V_2 = 2771.021$, is the shear force acting at edge 2 for the static loading combination

Calculation of Mu_{1+}

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

$\phi_u = 1.2093195E-005$

$M_u = 1.0296E+008$

with full section properties:

$b = 300.00$

$d = 357.00$

$d' = 42.00$

$v = 5.3972144E-005$

$N = 190.7537$

$f_c = 33.00$

ϕ_o (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_o) = 0.00721688$

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

From (5.4b), TBDY: $\phi_u = 0.00721688$

w_e (5.4c) = 0.00863449

a_{se} ((5.4d), TBDY) = 0.15672608

$b_o = 240.00$

$h_o = 340.00$

$bi_2 = 346400.00$

$$psh,min = \text{Min}(psh,x, psh,y) = 0.00261799$$

$$\begin{aligned} psh,x (5.4d) &= 0.00349066 \\ Ash &= Astir*ns = 78.53982 \\ \text{No stirups, ns} &= 2.00 \\ bk &= 300.00 \end{aligned}$$

$$\begin{aligned} psh,y (5.4d) &= 0.00261799 \\ Ash &= Astir*ns = 78.53982 \\ \text{No stirups, ns} &= 2.00 \\ bk &= 400.00 \end{aligned}$$

$$\begin{aligned} s &= 150.00 \\ fywe &= 694.45 \\ fce &= 33.00 \end{aligned}$$

$$\begin{aligned} \text{From } ((5.A5), \text{TB DY}), \text{TB DY: } cc &= 0.00262167 \\ c &= \text{confinement factor} = 1.06217 \end{aligned}$$

$$\begin{aligned} y1 &= 0.00104853 \\ sh1 &= 0.00335528 \\ ft1 &= 349.5114 \\ fy1 &= 291.2595 \\ su1 &= 0.00335528 \end{aligned}$$

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

$$lo/lou,min = lb/ld = 0.19435406$$

$$su1 = 0.4*esu1_nominal ((5.5), \text{TB DY}) = 0.032$$

From table 5A.1, TB DY: esu1_nominal = 0.08,

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

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

$$\text{with } fs1 = fs = 291.2595$$

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

$$\begin{aligned} y2 &= 0.00104853 \\ sh2 &= 0.00335528 \\ ft2 &= 349.5114 \\ fy2 &= 291.2595 \\ su2 &= 0.00335528 \end{aligned}$$

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

$$lo/lou,min = lb/lb,min = 0.19435406$$

$$su2 = 0.4*esu2_nominal ((5.5), \text{TB DY}) = 0.032$$

From table 5A.1, TB DY: esu2_nominal = 0.08,

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

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

$$\text{with } fs2 = fs = 291.2595$$

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

$$\begin{aligned} yv &= 0.00104853 \\ shv &= 0.00335528 \\ ftv &= 349.5114 \\ fyv &= 291.2595 \\ suv &= 0.00335528 \end{aligned}$$

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

$$lo/lou,min = lb/ld = 0.19435406$$

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

From table 5A.1, TB DY: esuv_nominal = 0.08,

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

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

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

$$\text{with } fsv = fs = 291.2595$$

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

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.07508005$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.07611563$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.02537188$$

and confined core properties:

$$b = 240.00$$

$$d = 327.00$$

$$d' = 12.00$$

$$f_{cc} (5A.2, TBDY) = 35.05152$$

$$c_c (5A.5, TBDY) = 0.00262167$$

$$c = \text{confinement factor} = 1.06217$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.10246016$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.1038734$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.03462447$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

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

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$$s_u (4.9) = 0.22282326$$

$$M_u = M_{Rc} (4.14) = 1.0296E+008$$

$$u = s_u (4.1) = 1.2093195E-005$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$$l_b = 300.00$$

$$l_d = 1543.575$$

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

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

$$= 1$$

$$d_b = 14.46154$$

Mean strength value of all re-bars: $f_y = 694.45$

$$t = 1.18462$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 3.22215$$

$$n = 13.00$$

Calculation of M_{u1} -

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

$$u = 1.2082259E-005$$

$$M_u = 1.0444E+008$$

with full section properties:

$$b = 300.00$$

$$d = 358.00$$

$$d' = 43.00$$

$$v = 5.3821384E-005$$

$$N = 190.7537$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00721688$$

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

$$\text{From (5.4b), TBDY: } c_u = 0.00721688$$

$$w_e (5.4c) = 0.00863449$$

$$a_{se} ((5.4d), TBDY) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00261799$$

psh,x (5.4d) = 0.00349066
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 300.00

psh,y (5.4d) = 0.00261799
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00

s = 150.00
fywe = 694.45
fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00262167
c = confinement factor = 1.06217

y1 = 0.00104853
sh1 = 0.00335528

ft1 = 349.5114

fy1 = 291.2595

su1 = 0.00335528

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

lo/lou,min = lb/l_d = 0.19435406

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 = 291.2595

with Es1 = Es = 200000.00

y2 = 0.00104853

sh2 = 0.00335528

ft2 = 349.5114

fy2 = 291.2595

su2 = 0.00335528

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

lo/lou,min = lb/l_{b,min} = 0.19435406

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 = 291.2595

with Es2 = Es = 200000.00

yv = 0.00104853

shv = 0.00335528

ftv = 349.5114

fyv = 291.2595

suv = 0.00335528

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

lo/lou,min = lb/l_d = 0.19435406

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/l_d)^{2/3}), from 10.3.5, ASCE 41-17.

with fsv = fs = 291.2595

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.07590302

2 = Asl,com/(b*d)*(fs2/fc) = 0.07487033

v = Asl,mid/(b*d)*(fsv/fc) = 0.02530101

and confined core properties:

$$b = 240.00$$

$$d = 328.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 35.05152$$

$$cc (5A.5, TBDY) = 0.00262167$$

$$c = \text{confinement factor} = 1.06217$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.10355671$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.10214778$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.0345189$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$su (4.9) = 0.22429266$$

$$\mu_u = M_{Rc} (4.14) = 1.0444E+008$$

$$u = su (4.1) = 1.2082259E-005$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$$l_b = 300.00$$

$$l_d = 1543.575$$

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

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

$$= 1$$

$$d_b = 14.46154$$

Mean strength value of all re-bars: $f_y = 694.45$

$$t = 1.18462$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 3.22215$$

$$n = 13.00$$

Calculation of μ_{u2+}

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

$$u = 1.2065709E-005$$

$$\mu_u = 1.0305E+008$$

with full section properties:

$$b = 300.00$$

$$d = 358.00$$

$$d' = 43.00$$

$$v = 5.3821384E-005$$

$$N = 190.7537$$

$$f_c = 33.00$$

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

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \alpha) = 0.00721688$

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

From (5.4b), TBDY: $\mu_u = 0.00721688$

$$w_e (5.4c) = 0.00863449$$

$$a_{se} ((5.4d), TBDY) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00261799$$

$$p_{sh,x} (5.4d) = 0.00349066$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

No stirrups, $n_s = 2.00$
 $b_k = 300.00$

$p_{sh,y} (5.4d) = 0.00261799$
 $A_{sh} = A_{stir} * n_s = 78.53982$
No stirrups, $n_s = 2.00$
 $b_k = 400.00$

$s = 150.00$
 $f_{ywe} = 694.45$
 $f_{ce} = 33.00$

From ((5.A.5), TBDY), TBDY: $c_c = 0.00262167$
 $c = \text{confinement factor} = 1.06217$

$y_1 = 0.00104853$
 $sh_1 = 0.00335528$

$ft_1 = 349.5114$

$fy_1 = 291.2595$

$su_1 = 0.00335528$

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

$lo/lou, min = lb/ld = 0.19435406$

$su_1 = 0.4 * esu1_{nominal} ((5.5), TBDY) = 0.032$

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

For calculation of $esu1_{nominal}$ 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 $fs_1 = fs = 291.2595$

with $Es_1 = Es = 200000.00$

$y_2 = 0.00104853$

$sh_2 = 0.00335528$

$ft_2 = 349.5114$

$fy_2 = 291.2595$

$su_2 = 0.00335528$

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

$lo/lou, min = lb/lb, min = 0.19435406$

$su_2 = 0.4 * esu2_{nominal} ((5.5), TBDY) = 0.032$

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

For calculation of $esu2_{nominal}$ and y_2 , sh_2 , ft_2 , fy_2 , it is considered
characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.

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

with $fs_2 = fs = 291.2595$

with $Es_2 = Es = 200000.00$

$y_v = 0.00104853$

$sh_v = 0.00335528$

$ft_v = 349.5114$

$fy_v = 291.2595$

$suv = 0.00335528$

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

$lo/lou, min = lb/ld = 0.19435406$

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

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

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

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

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

with $fs_v = fs = 291.2595$

with $Es_v = Es = 200000.00$

$1 = A_{sl,ten}/(b*d) * (fs_1/f_c) = 0.07487033$

$2 = A_{sl,com}/(b*d) * (fs_2/f_c) = 0.07590302$

$v = A_{sl,mid}/(b*d) * (fs_v/f_c) = 0.02530101$

and confined core properties:

$b = 240.00$

$d = 328.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.10214778$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.10355671$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.0345189$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.22322862$
 $Mu = MRc (4.14) = 1.0305E+008$
 $u = su (4.1) = 1.2065709E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$
 $l_b = 300.00$
 $l_d = 1543.575$
 Calculation of l_b, \min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d, \min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 14.46154$
 Mean strength value of all re-bars: $f_y = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

Calculation of Mu_2 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.2109886E-005$
 $Mu = 1.0434E+008$

with full section properties:

$b = 300.00$
 $d = 357.00$
 $d' = 42.00$
 $v = 5.3972144E-005$
 $N = 190.7537$
 $f_c = 33.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00721688$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.00721688$
 $w_e (5.4c) = 0.00863449$
 $ase ((5.4d), TBDY) = 0.15672608$
 $bo = 240.00$
 $ho = 340.00$
 $bi2 = 346400.00$
 $psh, \min = \text{Min}(psh, x, psh, y) = 0.00261799$
 $psh, x (5.4d) = 0.00349066$
 $A_{sh} = A_{stir} * n_s = 78.53982$
 No stirups, $n_s = 2.00$
 $bk = 300.00$

psh,y (5.4d) = 0.00261799
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00

s = 150.00
fywe = 694.45
fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00262167
c = confinement factor = 1.06217

y1 = 0.00104853
sh1 = 0.00335528

ft1 = 349.5114

fy1 = 291.2595

su1 = 0.00335528

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

lo/lou,min = lb/d = 0.19435406

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 = 291.2595

with Es1 = Es = 200000.00

y2 = 0.00104853

sh2 = 0.00335528

ft2 = 349.5114

fy2 = 291.2595

su2 = 0.00335528

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

lo/lou,min = lb/lb,min = 0.19435406

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 = 291.2595

with Es2 = Es = 200000.00

yv = 0.00104853

shv = 0.00335528

ftv = 349.5114

fyv = 291.2595

suv = 0.00335528

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

lo/lou,min = lb/d = 0.19435406

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 = 291.2595

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.07611563

2 = Asl,com/(b*d)*(fs2/fc) = 0.07508005

v = Asl,mid/(b*d)*(fsv/fc) = 0.02537188

and confined core properties:

b = 240.00

d = 327.00

d' = 12.00

f_{cc} (5A.2, TBDY) = 35.05152
 c_c (5A.5, TBDY) = 0.00262167
 c = confinement factor = 1.06217
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.1038734$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.10246016$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.03462447$
 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) = 0.22389443
 $M_u = M_{Rc}$ (4.14) = 1.0434E+008
 $u = s_u$ (4.1) = 1.2109886E-005

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$
 $l_b = 300.00$
 $l_d = 1543.575$
 Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 14.46154$
 Mean strength value of all re-bars: $f_y = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 289894.477$

Calculation of Shear Strength at edge 1, $V_{r1} = 289894.477$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14: $V_c = 103724.534$
 $= 1$ (normal-weight concrete)
 $f'_c = 33.00$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $p_w = A_s/(b_w*d) = 0.00949023$
 A_s (tension reinf.) = 911.0619
 $b_w = 300.00$
 $d = 320.00$
 $V_u*d/M_u < 1 = 1.00$
 $M_u = 71454.459$
 $V_u = 2771.022$
 From (11.5.4.8), ACI 318-14: $V_s = 186169.943$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$
 V_s 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: $V_s + V_f \leq 366348.956$

Calculation of Shear Strength at edge 2, $V_{r2} = 289894.477$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14: $V_c = 103724.534$
 $= 1$ (normal-weight concrete)
 $f'_c = 33.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00949023$
 A_s (tension reinf.) = 911.0619
 $b_w = 300.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 1.00$
 $M_u = 71455.367$
 $V_u = 2771.021$
 From (11.5.4.8), ACI 318-14: $V_s = 186169.943$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$
 V_s has been multiplied by 1 ($s \leq d/2$, according to ASCE 41-17, 10.3.4)
 V_f ((11-3)-(11.4), ACI 440) = 0.00
 From (11-11), ACI 440: $V_s + V_f \leq 366348.956$

 End Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1
 At local axis: 3

 Start Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1
 At Shear local axis: 2
 (Bending local axis: 3)
 Section Type: rcars

Constant Properties

 Knowledge Factor, $\phi = 1.00$
 Mean strength values are used for both shear and moment calculations.
 Consequently:
 New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
 New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$
 Concrete Elasticity, $E_c = 26999.444$
 Steel Elasticity, $E_s = 200000.00$
 #####
 Note: Especially for the calculation of moment strengths,
 the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
 New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 694.45$
 #####
 Section Height, $H = 400.00$
 Section Width, $W = 300.00$
 Cover Thickness, $c = 25.00$
 Mean Confinement Factor overall section = 1.06217
 Element Length, $L = 1850.00$
 Secondary Member
 Smooth Bars
 Ductile Steel
 With Detailing for Earthquake Resistance (including stirrups closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $l_o = 300.00$
 No FRP Wrapping

Stepwise Properties

 At local axis: 2
 EDGE -A-
 Shear Force, $V_a = -2.7041243E-015$
 EDGE -B-
 Shear Force, $V_b = 2.7041243E-015$
 BOTH EDGES
 Axial Force, $F = -190.7537$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 911.0619$

-Compression: $A_{sc} = 1231.504$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{st,ten} = 816.8141$

-Compression: $A_{sc,com} = 816.8141$

-Middle: $A_{st,mid} = 508.938$

Calculation of Shear Capacity ratio , $V_e/V_r = 0.38581165$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 74445.088$ with

$M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 6.8862E+007$

$\mu_{u1+} = 6.8862E+007$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$\mu_{u1-} = 6.8862E+007$, 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

$M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 6.8862E+007$

$\mu_{u2+} = 6.8862E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination

$\mu_{u2-} = 6.8862E+007$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination

and

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

with

$V_1 = -2.7041243E-015$, is the shear force acting at edge 1 for the static loading combination

$V_2 = 2.7041243E-015$, is the shear force acting at edge 2 for the static loading combination

Calculation of μ_{u1+}

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

$\phi_u = 1.7004869E-005$

$M_u = 6.8862E+007$

with full section properties:

$b = 400.00$

$d = 258.00$

$d' = 42.00$

$v = 5.6011789E-005$

$N = 190.7537$

$f_c = 33.00$

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

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00721688$

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

From (5.4b), TBDY: $\phi_u = 0.00721688$

$w_e (5.4c) = 0.00863449$

$a_{se} ((5.4d), \text{TBDY}) = 0.15672608$

$b_o = 240.00$

$h_o = 340.00$

$b_{i2} = 346400.00$

$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00261799$

$p_{sh,x} (5.4d) = 0.00349066$

$A_{sh} = A_{stir} \cdot n_s = 78.53982$

No stirrups, $n_s = 2.00$

$b_k = 300.00$

$p_{sh,y} (5.4d) = 0.00261799$

$A_{sh} = A_{stir} \cdot n_s = 78.53982$

No stirrups, $n_s = 2.00$

$b_k = 400.00$

```

s = 150.00
fywe = 694.45
fce = 33.00
From ((5A.5), TBDY), TBDY: cc = 0.00262167
c = confinement factor = 1.06217
y1 = 0.00104853
sh1 = 0.00335528
ft1 = 349.5114
fy1 = 291.2595
su1 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 0.19435406
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 = 291.2595
with Es1 = Es = 200000.00
y2 = 0.00104853
sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.19435406
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 = 291.2595
with Es2 = Es = 200000.00
yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 0.19435406
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 = 291.2595
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06985696
2 = Asl,com/(b*d)*(fs2/fc) = 0.06985696
v = Asl,mid/(b*d)*(fsv/fc) = 0.04352626
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 35.05152
cc (5A.5, TBDY) = 0.00262167
c = confinement factor = 1.06217
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09299842
2 = Asl,com/(b*d)*(fs2/fc) = 0.09299842

```

$$v = A_{sl, mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.05794517$$

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

--->

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

--->

$$s_u(4.9) = 0.23522079$$

$$M_u = M_{Rc}(4.14) = 6.8862E+007$$

$$u = s_u(4.1) = 1.7004869E-005$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$$l_b = 300.00$$

$$l_d = 1543.575$$

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

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

$$= 1$$

$$d_b = 14.46154$$

Mean strength value of all re-bars: $f_y = 694.45$

$$t = 1.18462$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 3.22215$$

$$n = 13.00$$

Calculation of M_{u1} -

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

$$u = 1.7004869E-005$$

$$M_u = 6.8862E+007$$

with full section properties:

$$b = 400.00$$

$$d = 258.00$$

$$d' = 42.00$$

$$v = 5.6011789E-005$$

$$N = 190.7537$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} \cdot \text{Max}(c_u, c_c) = 0.00721688$$

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

$$\text{From (5.4b), TBDY: } c_u = 0.00721688$$

$$w_e(5.4c) = 0.00863449$$

$$a_{se}((5.4d), TBDY) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00261799$$

$$p_{sh,x}(5.4d) = 0.00349066$$

$$A_{sh} = A_{stir} \cdot n_s = 78.53982$$

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

$$b_k = 300.00$$

$$p_{sh,y}(5.4d) = 0.00261799$$

$$A_{sh} = A_{stir} \cdot n_s = 78.53982$$

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

$$b_k = 400.00$$

$$s = 150.00$$


```

fywe = 694.45
fce = 33.00
From ((5A.5), TBDY), TBDY: cc = 0.00262167
c = confinement factor = 1.06217
y1 = 0.00104853
sh1 = 0.00335528
ft1 = 349.5114
fy1 = 291.2595
su1 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.19435406
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 291.2595
with Es1 = Es = 200000.00
y2 = 0.00104853
sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.19435406
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 291.2595
with Es2 = Es = 200000.00
yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.19435406
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 291.2595
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06985696
2 = Asl,com/(b*d)*(fs2/fc) = 0.06985696
v = Asl,mid/(b*d)*(fsv/fc) = 0.04352626
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 35.05152
cc (5A.5, TBDY) = 0.00262167
c = confinement factor = 1.06217
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09299842
2 = Asl,com/(b*d)*(fs2/fc) = 0.09299842
v = Asl,mid/(b*d)*(fsv/fc) = 0.05794517
Case/Assumption: Unconfinedsd full section - Steel rupture

```

satisfies Eq. (4.3)

--->

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

--->

μ_u (4.9) = 0.23522079

$M_u = M_{Rc}$ (4.14) = 6.8862E+007

$u = \mu_u$ (4.1) = 1.7004869E-005

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$l_b = 300.00$

$l_d = 1543.575$

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

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

= 1

$d_b = 14.46154$

Mean strength value of all re-bars: $f_y = 694.45$

$t = 1.18462$

$s = 0.80$

$e = 1.00$

$c_b = 25.00$

$K_{tr} = 3.22215$

$n = 13.00$

Calculation of μ_{u2+}

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

$u = 1.7004869E-005$

$M_u = 6.8862E+007$

with full section properties:

$b = 400.00$

$d = 258.00$

$d' = 42.00$

$v = 5.6011789E-005$

$N = 190.7537$

$f_c = 33.00$

ϕ (5A.5, TBDY) = 0.002

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.00721688$

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

From (5.4b), TBDY: $\mu_u = 0.00721688$

μ_w (5.4c) = 0.00863449

μ_{ase} ((5.4d), TBDY) = 0.15672608

$b_o = 240.00$

$h_o = 340.00$

$b_{i2} = 346400.00$

$\mu_{psh,min} = \text{Min}(\mu_{psh,x}, \mu_{psh,y}) = 0.00261799$

$\mu_{psh,x}$ (5.4d) = 0.00349066

$A_{sh} = A_{stir} * n_s = 78.53982$

No stirrups, $n_s = 2.00$

$b_k = 300.00$

$\mu_{psh,y}$ (5.4d) = 0.00261799

$A_{sh} = A_{stir} * n_s = 78.53982$

No stirrups, $n_s = 2.00$

$b_k = 400.00$

$s = 150.00$

$f_{ywe} = 694.45$

$f_{ce} = 33.00$

From ((5.A.5), TBDY), TBDY: $cc = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $y1 = 0.00104853$
 $sh1 = 0.00335528$
 $ft1 = 349.5114$
 $fy1 = 291.2595$
 $su1 = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/ld = 0.19435406$
 $su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu1_nominal = 0.08$,
 For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = fs = 291.2595$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00104853$
 $sh2 = 0.00335528$
 $ft2 = 349.5114$
 $fy2 = 291.2595$
 $su2 = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/lb,min = 0.19435406$
 $su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = fs = 291.2595$
 with $Es2 = Es = 200000.00$
 $yv = 0.00104853$
 $shv = 0.00335528$
 $ftv = 349.5114$
 $fyv = 291.2595$
 $suv = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/ld = 0.19435406$
 $suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 291.2595$
 with $Esv = Es = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.06985696$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.06985696$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.04352626$
 and confined core properties:
 $b = 340.00$
 $d = 228.00$
 $d' = 12.00$
 $fcc (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.09299842$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.09299842$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.05794517$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->

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

---->

$$s_u(4.9) = 0.23522079$$

$$M_u = M_{Rc}(4.14) = 6.8862E+007$$

$$u = s_u(4.1) = 1.7004869E-005$$

Calculation of ratio l_b/l_d

$$\text{Lap Length: } l_b/l_d = 0.19435406$$

$$l_b = 300.00$$

$$l_d = 1543.575$$

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

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

$$= 1$$

$$d_b = 14.46154$$

$$\text{Mean strength value of all re-bars: } f_y = 694.45$$

$$t = 1.18462$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 3.22215$$

$$n = 13.00$$

Calculation of M_u2 -

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

$$u = 1.7004869E-005$$

$$M_u = 6.8862E+007$$

with full section properties:

$$b = 400.00$$

$$d = 258.00$$

$$d' = 42.00$$

$$v = 5.6011789E-005$$

$$N = 190.7537$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00721688$$

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

$$\text{From (5.4b), TB DY: } c_u = 0.00721688$$

$$w_e(5.4c) = 0.00863449$$

$$a_{se}((5.4d), \text{TB DY}) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00261799$$

$$p_{sh,x}(5.4d) = 0.00349066$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 300.00$$

$$p_{sh,y}(5.4d) = 0.00261799$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TB DY), TB DY: } c_c = 0.00262167$$

$$c = \text{confinement factor} = 1.06217$$

```

y1 = 0.00104853
sh1 = 0.00335528
ft1 = 349.5114
fy1 = 291.2595
su1 = 0.00335528
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.19435406
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs1 = fs = 291.2595
    with Es1 = Es = 200000.00
y2 = 0.00104853
sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.19435406
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = fs = 291.2595
    with Es2 = Es = 200000.00
yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.19435406
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = fs = 291.2595
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06985696
2 = Asl,com/(b*d)*(fs2/fc) = 0.06985696
v = Asl,mid/(b*d)*(fsv/fc) = 0.04352626
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 35.05152
cc (5A.5, TBDY) = 0.00262167
c = confinement factor = 1.06217
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09299842
2 = Asl,com/(b*d)*(fs2/fc) = 0.09299842
v = Asl,mid/(b*d)*(fsv/fc) = 0.05794517
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
---->
v < vs,y2 - LHS eq.(4.5) is satisfied
---->

```

$s_u(4.9) = 0.23522079$
 $\mu_u = M_{Rc}(4.14) = 6.8862E+007$
 $u = s_u(4.1) = 1.7004869E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$l_b = 300.00$

$l_d = 1543.575$

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

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

$= 1$

$db = 14.46154$

Mean strength value of all re-bars: $f_y = 694.45$

$t = 1.18462$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 3.22215$

$n = 13.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 192957.075$

Calculation of Shear Strength at edge 1, $V_{r1} = 192957.075$

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

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

From Table (22.5.5.1), ACI 318-14: $V_c = 88236.482$

$= 1$ (normal-weight concrete)

$f'_c = 33.00$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$\rho_w = A_s/(b_w*d) = 0.00949023$

A_s (tension reinf.) = 911.0619

$b_w = 400.00$

$d = 240.00$

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

$\mu_u = 9.6361865E-012$

$V_u = 2.7041243E-015$

From (11.5.4.8), ACI 318-14: $V_s = 104720.593$

$A_v = 157079.633$

$f_y = 555.56$

$s = 150.00$

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

$2(1-s/d) = 0.75$

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

From (11-11), ACI 440: $V_s + V_f \leq 366348.956$

Calculation of Shear Strength at edge 2, $V_{r2} = 192957.075$

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

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

From Table (22.5.5.1), ACI 318-14: $V_c = 88236.482$

$= 1$ (normal-weight concrete)

$f'_c = 33.00$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$\rho_w = A_s/(b_w*d) = 0.00949023$

A_s (tension reinf.) = 911.0619

$b_w = 400.00$

$d = 240.00$

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

$\mu_u = 4.6338743E-012$

$$V_u = 2.7041243E-015$$

From (11.5.4.8), ACI 318-14: $V_s = 104720.593$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

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

$$2(1-s/d) = 0.75$$

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

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 366348.956$$

End Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam B1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 1850.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_b = 300.00$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 6.8260E+006$

Shear Force, $V_2 = -6.0183003E-014$

Shear Force, $V_3 = -4669.742$

Axial Force, $F = -612.5536$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{sl,t} = 911.0619$

-Compression: $A_{sl,c} = 1231.504$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten} = 911.0619$

-Compression: $A_{sl,com} = 923.6282$

-Middle: $A_{sl,mid} = 307.8761$

Mean Diameter of Tension Reinforcement, $D_bL = 15.20$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^* u = 0.00827915$

$$u = \gamma + p = 0.00827915$$

- Calculation of γ -

$y = (M_y \cdot L_s / 3) / E_{eff} = 0.00327915$ ((4.29), Biskinis Phd))
 $M_y = 8.7218E+007$
 $L_s = M/V$ (with $L_s > 0.1 \cdot L$ and $L_s < 2 \cdot L$) = 1461.749
 From table 10.5, ASCE 41_17: $E_{eff} = 0.3 \cdot E_c \cdot I_g = 1.2960E+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 5.2910708E-006$
 with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 \cdot f_y \cdot (l_b/d)^{2/3}) = 270.3814$
 $d = 357.00$
 $y = 0.28429351$
 $A = 0.02002644$
 $B = 0.01114881$
 with $p_t = 0.00850665$
 $p_c = 0.00862398$
 $p_v = 0.00287466$
 $N = 612.5536$
 $b = 300.00$
 $" = 0.11764706$
 $y_{comp} = 2.1691827E-005$
 with $f_c = 33.00$
 $E_c = 26999.444$
 $y = 0.28409741$
 $A = 0.01999229$
 $B = 0.01112766$
 with $E_s = 200000.00$

Calculation of ratio l_b/d

Lap Length: $l_d/d, \text{min} = 0.24294258$
 $l_b = 300.00$
 $l_d = 1234.86$
 Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d, min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
 $= 1$
 $db = 14.46154$
 Mean strength value of all re-bars: $f_y = 555.56$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

- Calculation of p -

From table 10-7: $p = 0.005$

with:

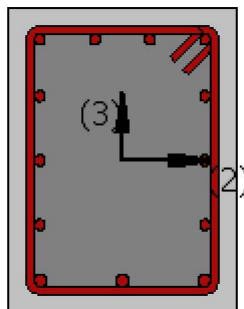
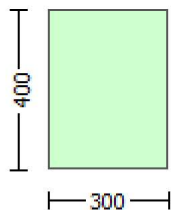
- Condition iv occurred
Beam controlled by inadequate embedment into beam-column joint:
($l_b/d < 1$ and With Lapping in the Vicinity of the End Regions)
- Condition i occurred
Beam controlled by flexure: $V_p/V_o \leq 1$
shear control ratio $V_p/V_o = 0.39885187$
- Transverse Reinforcement: NC
- Stirrup Spacing $> d/3$
- Low ductility demand, $\gamma < 2$ (table 10-6, ASCE 41-17)
 $= 6.0440428E-005$

- Stirrup Spacing $\leq d/2$
 $d = 357.00$
 $s = 150.00$
- Strength provided by hoops $V_s < 3/4 \cdot \text{design Shear}$
 $V_s = 186169.943$, already given in calculation of shear control ratio
design Shear = 4669.742
- $(-)' / bal = -0.17558466$
 $= A_{st} / (b_w \cdot d) = 0.00850665$
Tension Reinf Area: $A_{st} = 911.0619$
 $' = A_{sc} / (b_w \cdot d) = 0.01149864$
Compression Reinf Area: $A_{sc} = 1231.504$
From (B-1), ACI 318-11: $bal = 0.01704017$
 $f_c = 33.00$
 $f_y = 555.56$
From 10.2.7.3, ACI 318-11: $\lambda = 0.65$
From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + f_y) = c_b / d_t = 0.003 / (0.003 + y) = 0.51922877$
 $y = 0.0027778$
- $V / (b_w \cdot d \cdot f_c^{0.5}) = 0.09140494$, NOTE: units in lb & in
 $b_w = 300.00$

End Of Calculation of Chord Rotation Capacity for element: beam B1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 3

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



Start Of Calculation of Shear Capacity for element: beam B1 of floor 1
At local axis: 3

Integration Section: (a)
Section Type: rcars

Constant Properties

Knowledge Factor, $\phi = 1.00$
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
New material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$
New material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$
Section Height, $H = 400.00$
Section Width, $W = 300.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 1850.00$
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_o = l_b = 300.00$
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, $M_a = 6.8260E+006$
Shear Force, $V_a = -4669.742$
EDGE -B-
Bending Moment, $M_b = 6.9394E+006$
Shear Force, $V_b = 10211.784$
BOTH EDGES
Axial Force, $F = -612.5536$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_t = 911.0619$
-Compression: $As_c = 1231.504$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{t,ten} = 911.0619$
-Compression: $As_{c,com} = 923.6282$
-Middle: $As_{mid} = 307.8761$
Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 15.20$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 247742.188$
 V_n ((22.5.1.1), ACI 318-14) = 247742.188

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

From Table (22.5.5.1), ACI 318-14: $V_c = 80190.58$
 $= 1$ (normal-weight concrete)
 $f_c' = 25.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00949023$
 A_s (tension reinf.) = 911.0619
 $b_w = 300.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 0.21891587$
 $M_u = 6.8260E+006$
 $V_u = 4669.742$
From (11.5.4.8), ACI 318-14: $V_s = 167551.608$
 $A_v = 157079.633$
 $f_y = 500.00$

$$s = 150.00$$

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

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

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 318865.838$$

End Of Calculation of Shear Capacity for element: beam B1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 4

beam B1, Floor 1

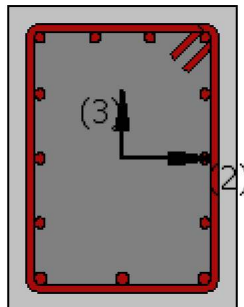
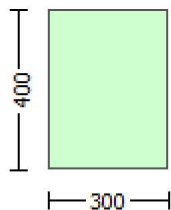
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (ϕ)

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

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

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

#####

Section Height, $H = 400.00$

Section Width, $W = 300.00$
 Cover Thickness, $c = 25.00$
 Mean Confinement Factor overall section = 1.06217
 Element Length, $L = 1850.00$
 Secondary Member
 Smooth Bars
 Ductile Steel
 With Detailing for Earthquake Resistance (including stirrups closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $l_o = 300.00$
 No FRP Wrapping

Stepwise Properties

At local axis: 3
 EDGE -A-
 Shear Force, $V_a = 2771.022$
 EDGE -B-
 Shear Force, $V_b = 2771.021$
 BOTH EDGES
 Axial Force, $F = -190.7537$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 911.0619$
 -Compression: $As_c = 1231.504$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 911.0619$
 -Compression: $As_{c,com} = 923.6282$
 -Middle: $As_{l,mid} = 307.8761$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.39885187$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 115624.954$
 with
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 1.0444E+008$
 $\mu_{u1+} = 1.0296E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{u1-} = 1.0444E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 1.0434E+008$
 $\mu_{u2+} = 1.0305E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{u2-} = 1.0434E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
 and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
 with
 $V_1 = 2771.022$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 2771.021$, is the shear force acting at edge 2 for the static loading combination

Calculation of μ_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 1.2093195E-005$
 $M_u = 1.0296E+008$

with full section properties:

$b = 300.00$
 $d = 357.00$
 $d' = 42.00$
 $v = 5.3972144E-005$

$N = 190.7537$
 $f_c = 33.00$
 $\alpha (5A.5, TBDY) = 0.002$
 Final value of α : $\alpha^* = \text{shear_factor} * \text{Max}(\alpha, \alpha_c) = 0.00721688$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\alpha = 0.00721688$
 $w_e (5.4c) = 0.00863449$
 $\alpha_{se} ((5.4d), TBDY) = 0.15672608$
 $b_o = 240.00$
 $h_o = 340.00$
 $b_i^2 = 346400.00$
 $p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00261799$

$p_{sh,x} (5.4d) = 0.00349066$
 $A_{sh} = A_{stir} * n_s = 78.53982$
 No stirrups, $n_s = 2.00$
 $b_k = 300.00$

$p_{sh,y} (5.4d) = 0.00261799$
 $A_{sh} = A_{stir} * n_s = 78.53982$
 No stirrups, $n_s = 2.00$
 $b_k = 400.00$

$s = 150.00$
 $f_{ywe} = 694.45$
 $f_{ce} = 33.00$
 From ((5A5), TBDY), TBDY: $\alpha_c = 0.00262167$
 $\alpha_c = \text{confinement factor} = 1.06217$
 $y_1 = 0.00104853$
 $sh_1 = 0.00335528$
 $ft_1 = 349.5114$
 $fy_1 = 291.2595$
 $su_1 = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.19435406$
 $su_1 = 0.4 * \alpha_{su1_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $\alpha_{su1_nominal} = 0.08$,
 For calculation of $\alpha_{su1_nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $f_{sy1} = f_{s1}/1.2$, from table 5.1, 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 $f_{s1} = f_s = 291.2595$
 with $E_{s1} = E_s = 200000.00$
 $y_2 = 0.00104853$
 $sh_2 = 0.00335528$
 $ft_2 = 349.5114$
 $fy_2 = 291.2595$
 $su_2 = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.19435406$
 $su_2 = 0.4 * \alpha_{su2_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $\alpha_{su2_nominal} = 0.08$,
 For calculation of $\alpha_{su2_nominal}$ 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 $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{s2} = f_s = 291.2595$
 with $E_{s2} = E_s = 200000.00$
 $y_v = 0.00104853$
 $sh_v = 0.00335528$
 $ft_v = 349.5114$
 $fy_v = 291.2595$
 $suv = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 0.19435406$
 $s_u = 0.4 * e_{suv,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $e_{suv,nominal} = 0.08$,
 considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $e_{suv,nominal}$ and y_v , sh_v, ft_v, fy_v , it is considered
 characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1 , sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = f_s = 291.2595$
 with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b*d) * (f_{s1}/f_c) = 0.07508005$
 $2 = A_{sl,com}/(b*d) * (f_{s2}/f_c) = 0.07611563$
 $v = A_{sl,mid}/(b*d) * (f_{sv}/f_c) = 0.02537188$

and confined core properties:

$b = 240.00$
 $d = 327.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = A_{sl,ten}/(b*d) * (f_{s1}/f_c) = 0.10246016$
 $2 = A_{sl,com}/(b*d) * (f_{s2}/f_c) = 0.1038734$
 $v = A_{sl,mid}/(b*d) * (f_{sv}/f_c) = 0.03462447$

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

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $s_u (4.9) = 0.22282326$
 $\mu_u = M_{Rc} (4.14) = 1.0296E+008$
 $u = s_u (4.1) = 1.2093195E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$
 $l_b = 300.00$
 $l_d = 1543.575$
 Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 14.46154$
 Mean strength value of all re-bars: $f_y = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

Calculation of μ_{u1} -

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.2082259E-005$
 $\mu_u = 1.0444E+008$

with full section properties:

$b = 300.00$
 $d = 358.00$
 $d' = 43.00$
 $v = 5.3821384E-005$
 $N = 190.7537$
 $f_c = 33.00$

```

co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00721688
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00721688
we (5.4c) = 0.00863449
ase ((5.4d), TBDY) = 0.15672608
bo = 240.00
ho = 340.00
bi2 = 346400.00
psh,min = Min(psh,x , psh,y) = 0.00261799
-----
psh,x (5.4d) = 0.00349066
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 300.00
-----
psh,y (5.4d) = 0.00261799
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
-----
s = 150.00
fywe = 694.45
fce = 33.00
From ((5A.5), TBDY), TBDY: cc = 0.00262167
c = confinement factor = 1.06217
y1 = 0.00104853
sh1 = 0.00335528
ft1 = 349.5114
fy1 = 291.2595
su1 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.19435406
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 291.2595
with Es1 = Es = 200000.00
y2 = 0.00104853
sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.19435406
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 291.2595
with Es2 = Es = 200000.00
yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.19435406

```

$suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv , shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 291.2595$
 with $Esv = Es = 200000.00$
 $1 = Asl,ten / (b * d) * (fs1 / fc) = 0.07590302$
 $2 = Asl,com / (b * d) * (fs2 / fc) = 0.07487033$
 $v = Asl,mid / (b * d) * (fsv / fc) = 0.02530101$

and confined core properties:

$b = 240.00$
 $d = 328.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = Asl,ten / (b * d) * (fs1 / fc) = 0.10355671$
 $2 = Asl,com / (b * d) * (fs2 / fc) = 0.10214778$
 $v = Asl,mid / (b * d) * (fsv / fc) = 0.0345189$

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

--->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied
 ---->
 $su (4.9) = 0.22429266$
 $Mu = MRc (4.14) = 1.0444E+008$
 $u = su (4.1) = 1.2082259E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.19435406$
 $lb = 300.00$
 $ld = 1543.575$
 Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 14.46154$
 Mean strength value of all re-bars: $fy = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 3.22215$
 $n = 13.00$

Calculation of $Mu2+$

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.2065709E-005$
 $Mu = 1.0305E+008$

with full section properties:

$b = 300.00$
 $d = 358.00$
 $d' = 43.00$
 $v = 5.3821384E-005$
 $N = 190.7537$
 $fc = 33.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00721688$

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

From (5.4b), TBDY: $c_u = 0.00721688$

w_e (5.4c) = 0.00863449

a_{se} ((5.4d), TBDY) = 0.15672608

$b_o = 240.00$

$h_o = 340.00$

$b_i^2 = 346400.00$

$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00261799$

$p_{sh,x}$ (5.4d) = 0.00349066

$A_{sh} = A_{stir} \cdot n_s = 78.53982$

No stirrups, $n_s = 2.00$

$b_k = 300.00$

$p_{sh,y}$ (5.4d) = 0.00261799

$A_{sh} = A_{stir} \cdot n_s = 78.53982$

No stirrups, $n_s = 2.00$

$b_k = 400.00$

$s = 150.00$

$f_{ywe} = 694.45$

$f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY: $c_c = 0.00262167$

$c = \text{confinement factor} = 1.06217$

$y_1 = 0.00104853$

$sh_1 = 0.00335528$

$ft_1 = 349.5114$

$fy_1 = 291.2595$

$su_1 = 0.00335528$

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

$l_o/l_{ou,min} = l_b/l_d = 0.19435406$

$su_1 = 0.4 \cdot esu1_{nominal}$ ((5.5), TBDY) = 0.032

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

For calculation of $esu1_{nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.

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

with $fs_1 = fs = 291.2595$

with $Es_1 = Es = 200000.00$

$y_2 = 0.00104853$

$sh_2 = 0.00335528$

$ft_2 = 349.5114$

$fy_2 = 291.2595$

$su_2 = 0.00335528$

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

$l_o/l_{ou,min} = l_b/l_{b,min} = 0.19435406$

$su_2 = 0.4 \cdot esu2_{nominal}$ ((5.5), TBDY) = 0.032

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

For calculation of $esu2_{nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.

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

with $fs_2 = fs = 291.2595$

with $Es_2 = Es = 200000.00$

$y_v = 0.00104853$

$sh_v = 0.00335528$

$ft_v = 349.5114$

$fy_v = 291.2595$

$su_v = 0.00335528$

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

$l_o/l_{ou,min} = l_b/l_d = 0.19435406$

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

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

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

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

with $f_{sv} = f_s = 291.2595$

with $E_{sv} = E_s = 200000.00$

$1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.07487033$

$2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.07590302$

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.02530101$

and confined core properties:

$b = 240.00$

$d = 328.00$

$d' = 13.00$

f_{cc} (5A.2, TBDY) = 35.05152

cc (5A.5, TBDY) = 0.00262167

c = confinement factor = 1.06217

$1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.10214778$

$2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.10355671$

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.0345189$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.22322862

$\mu_u = MR_c$ (4.14) = 1.0305E+008

$u = su$ (4.1) = 1.2065709E-005

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$l_b = 300.00$

$l_d = 1543.575$

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

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

= 1

$db = 14.46154$

Mean strength value of all re-bars: $f_y = 694.45$

$t = 1.18462$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 3.22215$

$n = 13.00$

Calculation of μ_{u2} -

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

$u = 1.2109886E-005$

$\mu_u = 1.0434E+008$

with full section properties:

$b = 300.00$

$d = 357.00$

$d' = 42.00$

$v = 5.3972144E-005$

$N = 190.7537$

$f_c = 33.00$

co (5A.5, TBDY) = 0.002

Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.00721688$

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

From (5.4b), TBDY: $cu = 0.00721688$

$w_e(5.4c) = 0.00863449$
 $a_{se}((5.4d), TBDY) = 0.15672608$
 $b_o = 240.00$
 $h_o = 340.00$
 $b_{i2} = 346400.00$
 $p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00261799$

$p_{sh,x}(5.4d) = 0.00349066$
 $A_{sh} = A_{stir} \cdot n_s = 78.53982$
 No stirrups, $n_s = 2.00$
 $b_k = 300.00$

$p_{sh,y}(5.4d) = 0.00261799$
 $A_{sh} = A_{stir} \cdot n_s = 78.53982$
 No stirrups, $n_s = 2.00$
 $b_k = 400.00$

$s = 150.00$
 $f_{ywe} = 694.45$
 $f_{ce} = 33.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $y_1 = 0.00104853$
 $sh_1 = 0.00335528$
 $ft_1 = 349.5114$
 $fy_1 = 291.2595$
 $su_1 = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $l_o/l_{ou,min} = l_b/l_d = 0.19435406$
 $su_1 = 0.4 \cdot esu_{1,nominal}((5.5), TBDY) = 0.032$
 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 $fsy_1 = f_s/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = f_s = 291.2595$
 with $Es_1 = E_s = 200000.00$
 $y_2 = 0.00104853$
 $sh_2 = 0.00335528$
 $ft_2 = 349.5114$
 $fy_2 = 291.2595$
 $su_2 = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.19435406$
 $su_2 = 0.4 \cdot esu_{2,nominal}((5.5), TBDY) = 0.032$
 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 $fsy_2 = f_s/1.2$, from table 5.1, TBDY.
 y_2, sh_2, ft_2, fy_2 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = f_s = 291.2595$
 with $Es_2 = E_s = 200000.00$
 $y_v = 0.00104853$
 $sh_v = 0.00335528$
 $ft_v = 349.5114$
 $fy_v = 291.2595$
 $su_v = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $l_o/l_{ou,min} = l_b/l_d = 0.19435406$
 $su_v = 0.4 \cdot esu_{v,nominal}((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{v,nominal} = 0.08$,
 considering characteristic value $fsy_v = f_{sv}/1.2$, 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 $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, f_{y1} , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = f_s = 291.2595$
 with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.07611563$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.07508005$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.02537188$

and confined core properties:

$b = 240.00$
 $d = 327.00$
 $d' = 12.00$
 $f_{cc} \text{ (5A.2, TBDY)} = 35.05152$
 $cc \text{ (5A.5, TBDY)} = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.1038734$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.10246016$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.03462447$

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

--->

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

--->

$su \text{ (4.9)} = 0.22389443$
 $Mu = MRc \text{ (4.14)} = 1.0434E+008$
 $u = su \text{ (4.1)} = 1.2109886E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$l_b = 300.00$

$l_d = 1543.575$

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

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

= 1

$db = 14.46154$

Mean strength value of all re-bars: $f_y = 694.45$

$t = 1.18462$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 3.22215$

$n = 13.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 289894.477$

Calculation of Shear Strength at edge 1, $V_{r1} = 289894.477$

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

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

From Table (22.5.5.1), ACI 318-14: $V_c = 103724.534$

= 1 (normal-weight concrete)

$f'_c = 33.00$, but $f_c^{0.5} \leq 8.3 \text{ MPa}$ (22.5.3.1, ACI 318-14)

$p_w = A_s/(b_w \cdot d) = 0.00949023$

$A_s \text{ (tension reinf.)} = 911.0619$

$b_w = 300.00$

$d = 320.00$

$V_u \cdot d / Mu < 1 = 1.00$

$Mu = 71454.459$

$V_u = 2771.022$

From (11.5.4.8), ACI 318-14: $V_s = 186169.943$

$A_v = 157079.633$

$$f_y = 555.56$$

$$s = 150.00$$

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

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

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 366348.956$$

Calculation of Shear Strength at edge 2, $V_{r2} = 289894.477$

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

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

$$\text{From Table (22.5.5.1), ACI 318-14: } V_c = 103724.534$$

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

$$f'_c = 33.00, \text{ but } f'_c^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$p_w = A_s / (b_w * d) = 0.00949023$$

$$A_s \text{ (tension reinf.)} = 911.0619$$

$$b_w = 300.00$$

$$d = 320.00$$

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

$$M_u = 71455.367$$

$$V_u = 2771.021$$

$$\text{From (11.5.4.8), ACI 318-14: } V_s = 186169.943$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

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

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

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 366348.956$$

End Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1

At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcars

Constant Properties

$$\text{Knowledge Factor, } = 1.00$$

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

Consequently:

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

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

$$\text{Concrete Elasticity, } E_c = 26999.444$$

$$\text{Steel Elasticity, } E_s = 200000.00$$

#####

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

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

#####

$$\text{Section Height, } H = 400.00$$

$$\text{Section Width, } W = 300.00$$

$$\text{Cover Thickness, } c = 25.00$$

$$\text{Mean Confinement Factor overall section} = 1.06217$$

$$\text{Element Length, } L = 1850.00$$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

$$\text{Lap Length } l_o = 300.00$$

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = -2.7041243E-015$

EDGE -B-

Shear Force, $V_b = 2.7041243E-015$

BOTH EDGES

Axial Force, $F = -190.7537$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 911.0619$

-Compression: $As_c = 1231.504$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 816.8141$

-Compression: $As_{l,com} = 816.8141$

-Middle: $As_{l,mid} = 508.938$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.38581165$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 74445.088$
with

$M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 6.8862E+007$

$Mu_{1+} = 6.8862E+007$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$Mu_{1-} = 6.8862E+007$, 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

$M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 6.8862E+007$

$Mu_{2+} = 6.8862E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination

$Mu_{2-} = 6.8862E+007$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination

and

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

with

$V_1 = -2.7041243E-015$, is the shear force acting at edge 1 for the static loading combination

$V_2 = 2.7041243E-015$, is the shear force acting at edge 2 for the static loading combination

Calculation of Mu_{1+}

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

$\phi_u = 1.7004869E-005$

$M_u = 6.8862E+007$

with full section properties:

$b = 400.00$

$d = 258.00$

$d' = 42.00$

$v = 5.6011789E-005$

$N = 190.7537$

$f_c = 33.00$

ϕ_o (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_o) = 0.00721688$

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

From (5.4b), TBDY: $\phi_u = 0.00721688$

w_e (5.4c) = 0.00863449

a_{se} ((5.4d), TBDY) = 0.15672608

$b_o = 240.00$

$h_o = 340.00$

$bi_2 = 346400.00$

$$psh,min = \text{Min}(psh,x, psh,y) = 0.00261799$$

$$psh,x (5.4d) = 0.00349066$$

$$Ash = Astir*ns = 78.53982$$

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

$$bk = 300.00$$

$$psh,y (5.4d) = 0.00261799$$

$$Ash = Astir*ns = 78.53982$$

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

$$bk = 400.00$$

$$s = 150.00$$

$$fywe = 694.45$$

$$fce = 33.00$$

$$\text{From } ((5.A5), \text{ TBDY}), \text{ TBDY: } cc = 0.00262167$$

$$c = \text{confinement factor} = 1.06217$$

$$y1 = 0.00104853$$

$$sh1 = 0.00335528$$

$$ft1 = 349.5114$$

$$fy1 = 291.2595$$

$$su1 = 0.00335528$$

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

$$lo/lou,min = lb/d = 0.19435406$$

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

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

$$\text{with } fs1 = fs = 291.2595$$

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

$$y2 = 0.00104853$$

$$sh2 = 0.00335528$$

$$ft2 = 349.5114$$

$$fy2 = 291.2595$$

$$su2 = 0.00335528$$

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

$$lo/lou,min = lb/lb,min = 0.19435406$$

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

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

$$\text{with } fs2 = fs = 291.2595$$

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

$$yv = 0.00104853$$

$$shv = 0.00335528$$

$$ftv = 349.5114$$

$$fyv = 291.2595$$

$$suv = 0.00335528$$

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

$$lo/lou,min = lb/d = 0.19435406$$

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

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

$$\text{with } fsv = fs = 291.2595$$

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

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.06985696$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.06985696$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.04352626$$

and confined core properties:

$$b = 340.00$$

$$d = 228.00$$

$$d' = 12.00$$

$$f_{cc} (5A.2, TBDY) = 35.05152$$

$$cc (5A.5, TBDY) = 0.00262167$$

$$c = \text{confinement factor} = 1.06217$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.09299842$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.09299842$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05794517$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$su (4.9) = 0.23522079$$

$$Mu = M_{Rc} (4.14) = 6.8862E+007$$

$$u = su (4.1) = 1.7004869E-005$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$$l_b = 300.00$$

$$l_d = 1543.575$$

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

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

$$= 1$$

$$d_b = 14.46154$$

Mean strength value of all re-bars: $f_y = 694.45$

$$t = 1.18462$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 3.22215$$

$$n = 13.00$$

Calculation of Mu_1 -

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

$$u = 1.7004869E-005$$

$$Mu = 6.8862E+007$$

with full section properties:

$$b = 400.00$$

$$d = 258.00$$

$$d' = 42.00$$

$$v = 5.6011789E-005$$

$$N = 190.7537$$

$$f_c = 33.00$$

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

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00721688$$

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

$$\text{From (5.4b), TBDY: } cu = 0.00721688$$

$$w_e (5.4c) = 0.00863449$$

$$ase ((5.4d), TBDY) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$bi_2 = 346400.00$$

$$psh,min = \text{Min}(psh,x, psh,y) = 0.00261799$$

psh,x (5.4d) = 0.00349066
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 300.00

psh,y (5.4d) = 0.00261799
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00

s = 150.00
fywe = 694.45
fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00262167
c = confinement factor = 1.06217

y1 = 0.00104853
sh1 = 0.00335528

ft1 = 349.5114

fy1 = 291.2595

su1 = 0.00335528

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

lo/lou,min = lb/ld = 0.19435406

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

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

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

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

with fs1 = fs = 291.2595

with Es1 = Es = 200000.00

y2 = 0.00104853

sh2 = 0.00335528

ft2 = 349.5114

fy2 = 291.2595

su2 = 0.00335528

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

lo/lou,min = lb/lb,min = 0.19435406

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

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

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

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

with fs2 = fs = 291.2595

with Es2 = Es = 200000.00

yv = 0.00104853

shv = 0.00335528

ftv = 349.5114

fyv = 291.2595

suv = 0.00335528

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

lo/lou,min = lb/ld = 0.19435406

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

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

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

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

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

with fsv = fs = 291.2595

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.06985696

2 = Asl,com/(b*d)*(fs2/fc) = 0.06985696

v = Asl,mid/(b*d)*(fsv/fc) = 0.04352626

and confined core properties:

$$b = 340.00$$

$$d = 228.00$$

$$d' = 12.00$$

$$fcc (5A.2, TBDY) = 35.05152$$

$$cc (5A.5, TBDY) = 0.00262167$$

$$c = \text{confinement factor} = 1.06217$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.09299842$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.09299842$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05794517$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$su (4.9) = 0.23522079$$

$$Mu = MRc (4.14) = 6.8862E+007$$

$$u = su (4.1) = 1.7004869E-005$$

Calculation of ratio l_b/l_d

$$\text{Lap Length: } l_b/l_d = 0.19435406$$

$$l_b = 300.00$$

$$l_d = 1543.575$$

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

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

$$= 1$$

$$db = 14.46154$$

Mean strength value of all re-bars: $f_y = 694.45$

$$t = 1.18462$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$K_{tr} = 3.22215$$

$$n = 13.00$$

Calculation of Mu_{2+}

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

$$u = 1.7004869E-005$$

$$Mu = 6.8862E+007$$

with full section properties:

$$b = 400.00$$

$$d = 258.00$$

$$d' = 42.00$$

$$v = 5.6011789E-005$$

$$N = 190.7537$$

$$f_c = 33.00$$

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

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00721688$$

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

$$\text{From (5.4b), TBDY: } cu = 0.00721688$$

$$w_e (5.4c) = 0.00863449$$

$$a_{se} ((5.4d), TBDY) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00261799$$

$$p_{sh,x} (5.4d) = 0.00349066$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

No stirrups, $n_s = 2.00$
 $b_k = 300.00$

 $p_{sh,y} (5.4d) = 0.00261799$
 $A_{sh} = A_{stir} * n_s = 78.53982$
No stirrups, $n_s = 2.00$
 $b_k = 400.00$

 $s = 150.00$
 $f_{ywe} = 694.45$
 $f_{ce} = 33.00$
From ((5.A.5), TBDY), TBDY: $c_c = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $y_1 = 0.00104853$
 $sh_1 = 0.00335528$
 $ft_1 = 349.5114$
 $fy_1 = 291.2595$
 $su_1 = 0.00335528$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.19435406$
 $su_1 = 0.4 * esu_1_{nominal} ((5.5), TBDY) = 0.032$
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 $fsy_1 = f_s/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs_1 = f_s = 291.2595$
with $E_{s1} = E_s = 200000.00$
 $y_2 = 0.00104853$
 $sh_2 = 0.00335528$
 $ft_2 = 349.5114$
 $fy_2 = 291.2595$
 $su_2 = 0.00335528$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.19435406$
 $su_2 = 0.4 * esu_2_{nominal} ((5.5), TBDY) = 0.032$
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 $fsy_2 = f_s/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs_2 = f_s = 291.2595$
with $E_{s2} = E_s = 200000.00$
 $y_v = 0.00104853$
 $sh_v = 0.00335528$
 $ft_v = 349.5114$
 $fy_v = 291.2595$
 $suv = 0.00335528$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.19435406$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
considering characteristic value $fsyv = f_{sv}/1.2$, from table 5.1, TBDY
For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
characteristic value $fsyv = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
with $f_{sv} = f_s = 291.2595$
with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b*d) * (f_{s1}/f_c) = 0.06985696$
 $2 = A_{sl,com}/(b*d) * (f_{s2}/f_c) = 0.06985696$
 $v = A_{sl,mid}/(b*d) * (f_{sv}/f_c) = 0.04352626$
and confined core properties:
 $b = 340.00$

$d = 228.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.09299842$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.09299842$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05794517$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.23522079$
 $Mu = MRc (4.14) = 6.8862E+007$
 $u = su (4.1) = 1.7004869E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$
 $l_b = 300.00$
 $l_d = 1543.575$
 Calculation of l_b, \min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d, \min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 14.46154$
 Mean strength value of all re-bars: $f_y = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

Calculation of Mu_2 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.7004869E-005$
 $Mu = 6.8862E+007$

with full section properties:

$b = 400.00$
 $d = 258.00$
 $d' = 42.00$
 $v = 5.6011789E-005$
 $N = 190.7537$
 $f_c = 33.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00721688$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.00721688$
 $w_e (5.4c) = 0.00863449$
 $ase ((5.4d), TBDY) = 0.15672608$
 $bo = 240.00$
 $ho = 340.00$
 $bi2 = 346400.00$
 $psh, \min = \text{Min}(psh, x, psh, y) = 0.00261799$
 $psh, x (5.4d) = 0.00349066$
 $A_{sh} = A_{stir} * n_s = 78.53982$
 No stirups, $n_s = 2.00$
 $bk = 300.00$

psh,y (5.4d) = 0.00261799
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00

s = 150.00
fywe = 694.45
fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00262167
c = confinement factor = 1.06217

y1 = 0.00104853
sh1 = 0.00335528

ft1 = 349.5114

fy1 = 291.2595

su1 = 0.00335528

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

lo/lou,min = lb/d = 0.19435406

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 = 291.2595

with Es1 = Es = 200000.00

y2 = 0.00104853

sh2 = 0.00335528

ft2 = 349.5114

fy2 = 291.2595

su2 = 0.00335528

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

lo/lou,min = lb/lb,min = 0.19435406

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 = 291.2595

with Es2 = Es = 200000.00

yv = 0.00104853

shv = 0.00335528

ftv = 349.5114

fyv = 291.2595

suv = 0.00335528

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

lo/lou,min = lb/d = 0.19435406

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 = 291.2595

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.06985696

2 = Asl,com/(b*d)*(fs2/fc) = 0.06985696

v = Asl,mid/(b*d)*(fsv/fc) = 0.04352626

and confined core properties:

b = 340.00

d = 228.00

d' = 12.00

f_{cc} (5A.2, TBDY) = 35.05152
 c_c (5A.5, TBDY) = 0.00262167
 c = confinement factor = 1.06217
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.09299842$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.09299842$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05794517$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 su (4.9) = 0.23522079
 $Mu = MRc$ (4.14) = 6.8862E+007
 $u = su$ (4.1) = 1.7004869E-005

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$
 $l_b = 300.00$
 $l_d = 1543.575$
 Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 14.46154$
 Mean strength value of all re-bars: $f_y = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 192957.075$

Calculation of Shear Strength at edge 1, $V_{r1} = 192957.075$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14: $V_c = 88236.482$
 $= 1$ (normal-weight concrete)
 $f'_c = 33.00$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $p_w = A_s/(b_w*d) = 0.00949023$
 A_s (tension reinf.) = 911.0619
 $b_w = 400.00$
 $d = 240.00$
 $V_u*d/Mu < 1 = 0.00$
 $Mu = 9.6361865E-012$
 $V_u = 2.7041243E-015$
 From (11.5.4.8), ACI 318-14: $V_s = 104720.593$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$
 V_s has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17, 10.3.4)
 $2(1-s/d) = 0.75$
 V_f ((11-3)-(11.4), ACI 440) = 0.00
 From (11-11), ACI 440: $V_s + V_f \leq 366348.956$

Calculation of Shear Strength at edge 2, $V_{r2} = 192957.075$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f*V_f$ '

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

From Table (22.5.5.1), ACI 318-14: $V_c = 88236.482$

= 1 (normal-weight concrete)

$f_c' = 33.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$\rho_w = A_s / (b_w \cdot d) = 0.00949023$

A_s (tension reinf.) = 911.0619

$b_w = 400.00$

$d = 240.00$

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

$M_u = 4.6338743E-012$

$V_u = 2.7041243E-015$

From (11.5.4.8), ACI 318-14: $V_s = 104720.593$

$A_v = 157079.633$

$f_y = 555.56$

$s = 150.00$

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

$2(1-s/d) = 0.75$

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

From (11-11), ACI 440: $V_s + V_f \leq 366348.956$

End Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam B1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcars

Constant Properties

Knowledge Factor, = 1.00

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

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 1850.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_b = 300.00$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = -6.3267464E-011$

Shear Force, $V_2 = -6.0183003E-014$

Shear Force, $V_3 = -4669.742$

Axial Force, $F = -612.5536$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 911.0619$

-Compression: $A_{sc} = 1231.504$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{st,ten} = 816.8141$

-Compression: $A_{st,com} = 816.8141$

-Middle: $Asl_{mid} = 508.938$

Mean Diameter of Tension Reinforcement, $DbL = 14.40$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.00756399$
 $u = y + p = 0.00756399$

- Calculation of y -

$y = (My * Ls / 3) / E_{eff} = 0.00256399$ ((4.29), Biskinis Phd))
 $My = 6.0620E+007$
 $Ls = M/V$ (with $Ls > 0.1 * L$ and $Ls < 2 * L$) = 925.00
From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 7.2898E+012$

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

$y = \min(y_{ten}, y_{com})$
 $y_{ten} = 7.4477525E-006$
with ((10.1), ASCE 41-17) $f_y = \min(f_y, 1.25 * f_y * (I_b / I_d)^{2/3}) = 270.3814$
 $d = 258.00$
 $y = 0.29643893$
 $A = 0.02078325$
 $B = 0.01209248$
with $p_t = 0.00791487$
 $p_c = 0.00791487$
 $p_v = 0.00493157$
 $N = 612.5536$
 $b = 400.00$
 $" = 0.1627907$
 $y_{comp} = 2.8784108E-005$
with $f_c = 33.00$
 $E_c = 26999.444$
 $y = 0.29625053$
 $A = 0.02074781$
 $B = 0.01207052$
with $E_s = 200000.00$

Calculation of ratio I_b / I_d

Lap Length: $I_d / I_{d,min} = 0.24294258$
 $I_b = 300.00$
 $I_d = 1234.86$
Calculation of I according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $I_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
 $= 1$
 $db = 14.46154$
Mean strength value of all re-bars: $f_y = 555.56$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

- Calculation of p -

From table 10-7: $p = 0.005$

with:

- Condition iv occurred
Beam controlled by inadequate embedment into beam-column joint:
($l_b/l_d < 1$ and With Lapping in the Vicinity of the End Regions)
- Condition i occurred
Beam controlled by flexure: $V_p/V_o \leq 1$
shear control ratio $V_p/V_o = 0.38581165$
- Transverse Reinforcement: NC
- Stirrup Spacing $> d/3$
- Low ductility demand, $\gamma < 2$ (table 10-6, ASCE 41-17)
 $\gamma = -1.1243915E-021$
- Stirrup Spacing $> d/2$
 $d = 258.00$
 $s = 150.00$
- Strength provided by hoops $V_s < 3/4 \cdot \text{design Shear}$
 $V_s = 139627.457$, already given in calculation of shear control ratio
design Shear = $6.0183003E-014$
- ($\rho_t - \rho'_t$)/ $\rho_{bal} = -0.18222013$
 $\rho_t = A_{st}/(b_w \cdot d) = 0.00882812$
Tension Reinf Area: $A_{st} = 911.0619$
 $\rho'_t = A_{sc}/(b_w \cdot d) = 0.01193318$
Compression Reinf Area: $A_{sc} = 1231.504$
From (B-1), ACI 318-11: $\rho_{bal} = 0.01704017$
 $f_c = 33.00$
 $f_y = 555.56$
From 10.2.7.3, ACI 318-11: $\beta_1 = 0.65$
From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + \gamma) = 0.51922877$
 $\gamma = 0.0027778$
- $V/(b_w \cdot d \cdot f_c^{0.5}) = 1.2225325E-018$, NOTE: units in lb & in
 $b_w = 400.00$

End Of Calculation of Chord Rotation Capacity for element: beam B1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 5

beam B1, Floor 1

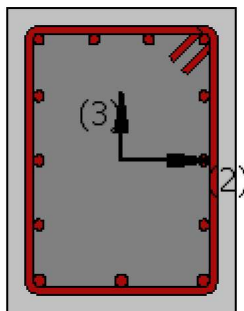
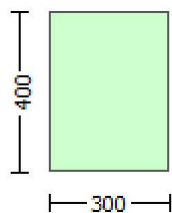
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: beam B1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

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

Consequently:

New material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 1850.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = l_b = 300.00$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = -6.3267464E-011$

Shear Force, $V_a = -6.0183003E-014$

EDGE -B-

Bending Moment, $M_b = -4.8101563E-011$

Shear Force, $V_b = 6.0183003E-014$

BOTH EDGES

Axial Force, $F = -612.5536$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 923.6282$

-Compression: $As_c = 1218.938$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 816.8141$

-Compression: $As_{c,com} = 816.8141$

-Middle: $As_{mid} = 508.938$

Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 14.40$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $VR = 1.0 \cdot V_n = 171047.78$

$V_n ((22.5.1.1), ACI 318-14) = 171047.78$

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

From Table (22.5.5.1), ACI 318-14: $V_c = 76800.00$

= 1 (normal-weight concrete)

$f'_c = 25.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$\rho_w = A_s / (b_w * d) = 0.00962113$

A_s (tension reinf.) = 923.6282

$b_w = 400.00$

$d = 240.00$

$V_u * d / M_u < 1 = 0.00$

$M_u = 4.8101563E-011$

$V_u = 6.0183003E-014$

From (11.5.4.8), ACI 318-14: $V_s = 94247.78$

$A_v = 157079.633$

$f_y = 500.00$

$s = 150.00$

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

$2(1-s/d) = 0.75$

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

From (11-11), ACI 440: $V_s + V_f \leq 318865.838$

End Of Calculation of Shear Capacity for element: beam B1 of floor 1

At local axis: 2

Integration Section: (b)

Calculation No. 6

beam B1, Floor 1

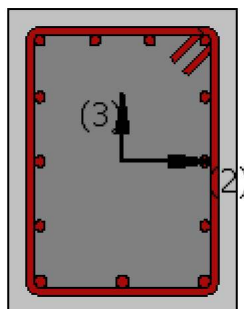
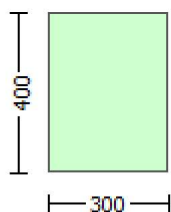
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (μ)

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)
Section Type: rcars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

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

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

#####

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.06217

Element Length, $L = 1850.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = 300.00$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 2771.022$

EDGE -B-

Shear Force, $V_b = 2771.021$

BOTH EDGES

Axial Force, $F = -190.7537$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 911.0619$

-Compression: $As_c = 1231.504$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 911.0619$

-Compression: $As_{l,com} = 923.6282$

-Middle: $As_{l,mid} = 307.8761$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.39885187$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 115624.954$

with

$M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 1.0444E+008$

$\mu_{u1+} = 1.0296E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$\mu_{u1-} = 1.0444E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

$M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 1.0434E+008$

$\mu_{u2+} = 1.0305E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

$\mu_{u2-} = 1.0434E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

and

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

with

V1 = 2771.022, is the shear force acting at edge 1 for the the static loading combination

V2 = 2771.021, is the shear force acting at edge 2 for the the static loading combination

Calculation of Mu1+

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

$\phi_u = 1.2093195E-005$

$M_u = 1.0296E+008$

with full section properties:

$b = 300.00$

$d = 357.00$

$d' = 42.00$

$\nu = 5.3972144E-005$

$N = 190.7537$

$f_c = 33.00$

ϕ_c (5A.5, TBDY) = 0.002

Final value of ϕ_{cu} : $\phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_c) = 0.00721688$

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

From (5.4b), TBDY: $\phi_{cu} = 0.00721688$

ϕ_{we} (5.4c) = 0.00863449

ϕ_{ase} ((5.4d), TBDY) = 0.15672608

$b_o = 240.00$

$h_o = 340.00$

$b_{i2} = 346400.00$

$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.00261799$

$\phi_{psh,x}$ (5.4d) = 0.00349066

$A_{sh} = A_{stir} * n_s = 78.53982$

No stirrups, $n_s = 2.00$

$b_k = 300.00$

$\phi_{psh,y}$ (5.4d) = 0.00261799

$A_{sh} = A_{stir} * n_s = 78.53982$

No stirrups, $n_s = 2.00$

$b_k = 400.00$

$s = 150.00$

$f_{ywe} = 694.45$

$f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY: $\phi_c = 0.00262167$

$\phi_c = \text{confinement factor} = 1.06217$

$\phi_{y1} = 0.00104853$

$\phi_{sh1} = 0.00335528$

$f_{t1} = 349.5114$

$f_{y1} = 291.2595$

$\phi_{su1} = 0.00335528$

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$\phi_{lo/lou,min} = \phi_b / \phi_d = 0.19435406$

$\phi_{su1} = 0.4 * \phi_{su1_nominal}$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $\phi_{su1_nominal} = 0.08$,

For calculation of $\phi_{su1_nominal}$ and $\phi_{y1}, \phi_{sh1}, f_{t1}, f_{y1}$, it is considered

characteristic value $f_{sy1} = f_s / 1.2$, from table 5.1, TBDY.

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

with $f_{s1} = f_s = 291.2595$

with $E_{s1} = E_s = 200000.00$

$\phi_{y2} = 0.00104853$

$\phi_{sh2} = 0.00335528$

$f_{t2} = 349.5114$

$f_{y2} = 291.2595$

$\phi_{su2} = 0.00335528$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.19435406$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs_2 = fs = 291.2595$
with $Es_2 = Es = 200000.00$
 $y_v = 0.00104853$
 $sh_v = 0.00335528$
 $ft_v = 349.5114$
 $fy_v = 291.2595$
 $suv = 0.00335528$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.19435406$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
considering characteristic value $fsy_v = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
characteristic value $fsy_v = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fsv = fs = 291.2595$
with $Es_v = Es = 200000.00$
 $1 = A_{sl,ten}/(b*d) * (fs_1/f_c) = 0.07508005$
 $2 = A_{sl,com}/(b*d) * (fs_2/f_c) = 0.07611563$
 $v = A_{sl,mid}/(b*d) * (fsv/f_c) = 0.02537188$
and confined core properties:
 $b = 240.00$
 $d = 327.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = A_{sl,ten}/(b*d) * (fs_1/f_c) = 0.10246016$
 $2 = A_{sl,com}/(b*d) * (fs_2/f_c) = 0.1038734$
 $v = A_{sl,mid}/(b*d) * (fsv/f_c) = 0.03462447$
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
 $v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied
--->
 $su (4.9) = 0.22282326$
 $Mu = MRc (4.14) = 1.0296E+008$
 $u = su (4.1) = 1.2093195E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$
 $l_b = 300.00$
 $l_d = 1543.575$
Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 14.46154$
Mean strength value of all re-bars: $fy = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

Calculation of Mu1-

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

$$\phi_u = 1.2082259E-005$$

$$M_u = 1.0444E+008$$

with full section properties:

$$b = 300.00$$

$$d = 358.00$$

$$d' = 43.00$$

$$\nu = 5.3821384E-005$$

$$N = 190.7537$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00721688$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00721688$$

$$\phi_{we} \text{ (5.4c)} = 0.00863449$$

$$\phi_{ase} \text{ ((5.4d), TBDY)} = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

$$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.00261799$$

$$\phi_{psh,x} \text{ (5.4d)} = 0.00349066$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 300.00$$

$$\phi_{psh,y} \text{ (5.4d)} = 0.00261799$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_{cc} = 0.00262167$$

$$c = \text{confinement factor} = 1.06217$$

$$y_1 = 0.00104853$$

$$sh_1 = 0.00335528$$

$$ft_1 = 349.5114$$

$$fy_1 = 291.2595$$

$$su_1 = 0.00335528$$

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

$$l_o/l_{ou,min} = l_b/l_d = 0.19435406$$

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

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

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.

$$\text{with } fs_1 = fs = 291.2595$$

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

$$y_2 = 0.00104853$$

$$sh_2 = 0.00335528$$

$$ft_2 = 349.5114$$

$$fy_2 = 291.2595$$

$$su_2 = 0.00335528$$

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

Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_{b,min} = 0.19435406$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 291.2595$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00104853$
 $sh_v = 0.00335528$
 $ft_v = 349.5114$
 $fy_v = 291.2595$
 $suv = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 0.19435406$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsy_v = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsy_v = fs_v/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = fs = 291.2595$
 with $Es_v = Es = 200000.00$
 $1 = A_{sl,ten}/(b * d) * (fs_1/f_c) = 0.07590302$
 $2 = A_{sl,com}/(b * d) * (fs_2/f_c) = 0.07487033$
 $v = A_{sl,mid}/(b * d) * (fs_v/f_c) = 0.02530101$

and confined core properties:

$b = 240.00$
 $d = 328.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = A_{sl,ten}/(b * d) * (fs_1/f_c) = 0.10355671$
 $2 = A_{sl,com}/(b * d) * (fs_2/f_c) = 0.10214778$
 $v = A_{sl,mid}/(b * d) * (fs_v/f_c) = 0.0345189$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.22429266$

$\mu_u = MR_c (4.14) = 1.0444E+008$

$u = su (4.1) = 1.2082259E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$l_b = 300.00$

$l_d = 1543.575$

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

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

= 1

$db = 14.46154$

Mean strength value of all re-bars: $fy = 694.45$

$t = 1.18462$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 3.22215$

$n = 13.00$

Calculation of Mu2+

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

$$\phi_u = 1.2065709E-005$$

$$\mu_u = 1.0305E+008$$

with full section properties:

$$b = 300.00$$

$$d = 358.00$$

$$d' = 43.00$$

$$\nu = 5.3821384E-005$$

$$N = 190.7537$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu} = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00721688$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00721688$$

$$\phi_{we} (5.4c) = 0.00863449$$

$$\phi_{ase} ((5.4d), TBDY) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

$$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.00261799$$

$$\phi_{psh,x} (5.4d) = 0.00349066$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 300.00$$

$$\phi_{psh,y} (5.4d) = 0.00261799$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_{cc} = 0.00262167$$

$$c = \text{confinement factor} = 1.06217$$

$$y_1 = 0.00104853$$

$$sh_1 = 0.00335528$$

$$f_{t1} = 349.5114$$

$$f_{y1} = 291.2595$$

$$su_1 = 0.00335528$$

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

$$l_o/l_{ou,min} = l_b/l_d = 0.19435406$$

$$su_1 = 0.4 * \phi_{su1_nominal} ((5.5), TBDY) = 0.032$$

$$\text{From table 5A.1, TBDY: } \phi_{su1_nominal} = 0.08,$$

For calculation of $\phi_{su1_nominal}$ and $y_1, sh_1, f_{t1}, f_{y1}$, it is considered
characteristic value $f_{sy1} = f_s/1.2$, 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.

$$\text{with } f_{s1} = f_s = 291.2595$$

$$\text{with } E_{s1} = E_s = 200000.00$$

$$y_2 = 0.00104853$$

$$sh_2 = 0.00335528$$

$$f_{t2} = 349.5114$$

$$f_{y2} = 291.2595$$

$$su_2 = 0.00335528$$

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

$$l_o/l_{ou,min} = l_b/l_{b,min} = 0.19435406$$

$su_2 = 0.4 \cdot esu_{2_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2_nominal} = 0.08$,
 For calculation of $esu_{2_nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 291.2595$
 with $Es_2 = Es = 200000.00$
 $yv = 0.00104853$
 $shv = 0.00335528$
 $ftv = 349.5114$
 $fyv = 291.2595$
 $suv = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lo_{u,min} = lb/ld = 0.19435406$
 $suv = 0.4 \cdot esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 291.2595$
 with $Es_v = Es = 200000.00$
 $1 = Asl_{ten}/(b \cdot d) \cdot (fs_1/fc) = 0.07487033$
 $2 = Asl_{com}/(b \cdot d) \cdot (fs_2/fc) = 0.07590302$
 $v = Asl_{mid}/(b \cdot d) \cdot (fsv/fc) = 0.02530101$

and confined core properties:

$b = 240.00$
 $d = 328.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = Asl_{ten}/(b \cdot d) \cdot (fs_1/fc) = 0.10214778$
 $2 = Asl_{com}/(b \cdot d) \cdot (fs_2/fc) = 0.10355671$
 $v = Asl_{mid}/(b \cdot d) \cdot (fsv/fc) = 0.0345189$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su (4.9) = 0.22322862$

$\mu_u = MR_c (4.14) = 1.0305E+008$

$u = su (4.1) = 1.2065709E-005$

 Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.19435406$

$lb = 300.00$

$ld = 1543.575$

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

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

= 1

$db = 14.46154$

Mean strength value of all re-bars: $fy = 694.45$

$t = 1.18462$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 3.22215$

$n = 13.00$

 Calculation of μ_{u2} -

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

$$\phi_u = 1.2109886E-005$$

$$\mu = 1.0434E+008$$

with full section properties:

$$b = 300.00$$

$$d = 357.00$$

$$d' = 42.00$$

$$\nu = 5.3972144E-005$$

$$N = 190.7537$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00721688$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00721688$$

$$\phi_{we} (5.4c) = 0.00863449$$

$$\phi_{ase} ((5.4d), TBDY) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_i^2 = 346400.00$$

$$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.00261799$$

$$\phi_{psh,x} (5.4d) = 0.00349066$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 300.00$$

$$\phi_{psh,y} (5.4d) = 0.00261799$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_{cc} = 0.00262167$$

$$c = \text{confinement factor} = 1.06217$$

$$y_1 = 0.00104853$$

$$sh_1 = 0.00335528$$

$$f_{t1} = 349.5114$$

$$f_{y1} = 291.2595$$

$$su_1 = 0.00335528$$

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

$$l_o/l_{o,min} = l_b/l_d = 0.19435406$$

$$su_1 = 0.4 * esu1_{nominal} ((5.5), TBDY) = 0.032$$

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

For calculation of $esu1_{nominal}$ and $y_1, sh_1, f_{t1}, f_{y1}$, it is considered
characteristic value $f_{sy1} = f_{s1}/1.2$, 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.

$$\text{with } f_{s1} = f_s = 291.2595$$

$$\text{with } E_{s1} = E_s = 200000.00$$

$$y_2 = 0.00104853$$

$$sh_2 = 0.00335528$$

$$f_{t2} = 349.5114$$

$$f_{y2} = 291.2595$$

$$su_2 = 0.00335528$$

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

$$l_o/l_{o,min} = l_b/l_{b,min} = 0.19435406$$

$$su_2 = 0.4 * esu2_{nominal} ((5.5), TBDY) = 0.032$$

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

For calculation of $es_{u2_nominal}$ and y_2 , $sh_{2,ft2,fy2}$, it is considered characteristic value $fs_{y2} = fs_2/1.2$, from table 5.1, TBDY.

y_1 , $sh_{1,ft1,fy1}$, are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_2 = fs = 291.2595$
with $Es_2 = Es = 200000.00$

$y_v = 0.00104853$
 $sh_v = 0.00335528$
 $ft_v = 349.5114$
 $fy_v = 291.2595$
 $suv = 0.00335528$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.19435406$
 $suv = 0.4 \cdot es_{u_nominal} ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $es_{u_nominal} = 0.08$,
considering characteristic value $fs_{yv} = fs_v/1.2$, from table 5.1, TBDY
For calculation of $es_{u_nominal}$ and y_v , sh_v , ft_v , fy_v , it is considered characteristic value $fs_{yv} = fs_v/1.2$, from table 5.1, TBDY.

y_1 , $sh_{1,ft1,fy1}$, are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_v = fs = 291.2595$
with $Es_v = Es = 200000.00$

$1 = A_{sl,ten}/(b \cdot d) \cdot (fs_1/f_c) = 0.07611563$
 $2 = A_{sl,com}/(b \cdot d) \cdot (fs_2/f_c) = 0.07508005$
 $v = A_{sl,mid}/(b \cdot d) \cdot (fs_v/f_c) = 0.02537188$

and confined core properties:

$b = 240.00$
 $d = 327.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (fs_1/f_c) = 0.1038734$
 $2 = A_{sl,com}/(b \cdot d) \cdot (fs_2/f_c) = 0.10246016$
 $v = A_{sl,mid}/(b \cdot d) \cdot (fs_v/f_c) = 0.03462447$

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

--->

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

--->

$su (4.9) = 0.22389443$
 $\mu_u = M_{Rc} (4.14) = 1.0434E+008$
 $u = su (4.1) = 1.2109886E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$l_b = 300.00$
 $l_d = 1543.575$

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

= 1

$db = 14.46154$
Mean strength value of all re-bars: $fy = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 289894.477$

Calculation of Shear Strength at edge 1, $V_{r1} = 289894.477$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14: $V_c = 103724.534$
= 1 (normal-weight concrete)
 $f_c' = 33.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s/(b_w*d) = 0.00949023$
 A_s (tension reinf.) = 911.0619
 $b_w = 300.00$
 $d = 320.00$
 $V_u*d/\mu < 1 = 1.00$
 $\mu = 71454.459$
 $V_u = 2771.022$

From (11.5.4.8), ACI 318-14: $V_s = 186169.943$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$
 V_s 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: $V_s + V_f \leq 366348.956$

Calculation of Shear Strength at edge 2, $V_{r2} = 289894.477$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14: $V_c = 103724.534$
= 1 (normal-weight concrete)
 $f_c' = 33.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s/(b_w*d) = 0.00949023$
 A_s (tension reinf.) = 911.0619
 $b_w = 300.00$
 $d = 320.00$
 $V_u*d/\mu < 1 = 1.00$
 $\mu = 71455.367$
 $V_u = 2771.021$

From (11.5.4.8), ACI 318-14: $V_s = 186169.943$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$
 V_s 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: $V_s + V_f \leq 366348.956$

End Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcars

Constant Properties

Knowledge Factor, $\phi = 1.00$
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$
Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 694.45$

#####

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.06217

Element Length, $L = 1850.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = 300.00$

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = -2.7041243E-015$

EDGE -B-

Shear Force, $V_b = 2.7041243E-015$

BOTH EDGES

Axial Force, $F = -190.7537$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 911.0619$

-Compression: $A_{sc} = 1231.504$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{st,ten} = 816.8141$

-Compression: $A_{sl,com} = 816.8141$

-Middle: $A_{sl,mid} = 508.938$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.38581165$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 74445.088$
with

$M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 6.8862E+007$

$\mu_{u1+} = 6.8862E+007$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination

$\mu_{u1-} = 6.8862E+007$, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination

$M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 6.8862E+007$

$\mu_{u2+} = 6.8862E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the static loading combination

$\mu_{u2-} = 6.8862E+007$, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the static loading combination

and

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

with

$V_1 = -2.7041243E-015$, is the shear force acting at edge 1 for the static loading combination

$V_2 = 2.7041243E-015$, is the shear force acting at edge 2 for the static loading combination

Calculation of μ_{u1+}

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

$\phi_u = 1.7004869E-005$

$$\mu = 6.8862E+007$$

with full section properties:

$$b = 400.00$$

$$d = 258.00$$

$$d' = 42.00$$

$$v = 5.6011789E-005$$

$$N = 190.7537$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi: \phi^* = \text{shear_factor} * \text{Max}(\phi_c, \phi_s) = 0.00721688$$

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

$$\text{From (5.4b), TB DY: } \phi_c = 0.00721688$$

$$\phi_s (5.4c) = 0.00863449$$

$$\phi_{se} ((5.4d), \text{TB DY}) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_i^2 = 346400.00$$

$$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00261799$$

$$\phi_{sh,x} (5.4d) = 0.00349066$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 300.00$$

$$\phi_{sh,y} (5.4d) = 0.00261799$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5A5), TB DY), TB DY: } \phi_c = 0.00262167$$

$$\phi_c = \text{confinement factor} = 1.06217$$

$$y_1 = 0.00104853$$

$$sh_1 = 0.00335528$$

$$f_{t1} = 349.5114$$

$$f_{y1} = 291.2595$$

$$su_1 = 0.00335528$$

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

$$l_o/l_{o,min} = l_b/l_d = 0.19435406$$

$$su_1 = 0.4 * esu1_{nominal} ((5.5), \text{TB DY}) = 0.032$$

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

For calculation of esu1_nominal and $y_1, sh_1, f_{t1}, f_{y1}$, it is considered characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TB DY.

$$y_1, sh_1, f_{t1}, f_{y1}, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b/l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_1 = fs = 291.2595$$

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

$$y_2 = 0.00104853$$

$$sh_2 = 0.00335528$$

$$f_{t2} = 349.5114$$

$$f_{y2} = 291.2595$$

$$su_2 = 0.00335528$$

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

$$l_o/l_{o,min} = l_b/l_{b,min} = 0.19435406$$

$$su_2 = 0.4 * esu2_{nominal} ((5.5), \text{TB DY}) = 0.032$$

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

For calculation of esu2_nominal and $y_2, sh_2, f_{t2}, f_{y2}$, it is considered characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TB DY.

$$y_1, sh_1, f_{t1}, f_{y1}, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b/l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_2 = fs = 291.2595$$

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

$y_v = 0.00104853$
 $sh_v = 0.00335528$
 $ft_v = 349.5114$
 $fy_v = 291.2595$
 $suv = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lo_{min} = lb/ld = 0.19435406$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fs_v = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fs_v = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 291.2595$
 with $Esv = Es = 200000.00$
 $1 = Asl_{ten}/(b*d)*(fs_1/fc) = 0.06985696$
 $2 = Asl_{com}/(b*d)*(fs_2/fc) = 0.06985696$
 $v = Asl_{mid}/(b*d)*(fsv/fc) = 0.04352626$

and confined core properties:

$b = 340.00$
 $d = 228.00$
 $d' = 12.00$
 $fcc (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = Asl_{ten}/(b*d)*(fs_1/fc) = 0.09299842$
 $2 = Asl_{com}/(b*d)*(fs_2/fc) = 0.09299842$
 $v = Asl_{mid}/(b*d)*(fsv/fc) = 0.05794517$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su (4.9) = 0.23522079$
 $Mu = MRc (4.14) = 6.8862E+007$
 $u = su (4.1) = 1.7004869E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.19435406$

$lb = 300.00$

$ld = 1543.575$

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

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

= 1

$db = 14.46154$

Mean strength value of all re-bars: $fy = 694.45$

$t = 1.18462$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$Ktr = 3.22215$

$n = 13.00$

Calculation of Mu_1 -

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

$u = 1.7004869E-005$

$Mu = 6.8862E+007$

with full section properties:

$$b = 400.00$$

$$d = 258.00$$

$$d' = 42.00$$

$$v = 5.6011789E-005$$

$$N = 190.7537$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_c: \phi_c^* = \text{shear_factor} * \text{Max}(\phi_c, \phi_c) = 0.00721688$$

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

$$\text{From (5.4b), TB DY: } \phi_c = 0.00721688$$

$$\phi_w (5.4c) = 0.00863449$$

$$\phi_{se} ((5.4d), \text{TB DY}) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_i^2 = 346400.00$$

$$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00261799$$

$$\phi_{sh,x} (5.4d) = 0.00349066$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 300.00$$

$$\phi_{sh,y} (5.4d) = 0.00261799$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TB DY), TB DY: } \phi_c = 0.00262167$$

$$c = \text{confinement factor} = 1.06217$$

$$y_1 = 0.00104853$$

$$sh_1 = 0.00335528$$

$$f_{t1} = 349.5114$$

$$f_{y1} = 291.2595$$

$$su_1 = 0.00335528$$

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

$$l_o/l_{ou,min} = l_b/l_d = 0.19435406$$

$$su_1 = 0.4 * esu_1_{nominal} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu_1_{nominal} = 0.08,$$

For calculation of $esu_1_{nominal}$ and $y_1, sh_1, f_{t1}, f_{y1}$, it is considered
characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TB DY.

$y_1, sh_1, f_{t1}, f_{y1}$, are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_1 = fs = 291.2595$$

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

$$y_2 = 0.00104853$$

$$sh_2 = 0.00335528$$

$$f_{t2} = 349.5114$$

$$f_{y2} = 291.2595$$

$$su_2 = 0.00335528$$

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

$$l_o/l_{ou,min} = l_b/l_{b,min} = 0.19435406$$

$$su_2 = 0.4 * esu_2_{nominal} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu_2_{nominal} = 0.08,$$

For calculation of $esu_2_{nominal}$ and $y_2, sh_2, f_{t2}, f_{y2}$, it is considered
characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TB DY.

$y_1, sh_1, f_{t1}, f_{y1}$, are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_2 = fs = 291.2595$$

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

$$y_v = 0.00104853$$

$$sh_v = 0.00335528$$

```

ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/ld = 0.19435406
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = fs = 291.2595
    with Esv = Es = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.06985696
    2 = Asl,com/(b*d)*(fs2/fc) = 0.06985696
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04352626
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 35.05152
cc (5A.5, TBDY) = 0.00262167
    c = confinement factor = 1.06217
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.09299842
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09299842
    v = Asl,mid/(b*d)*(fsv/fc) = 0.05794517
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.23522079
Mu = MRc (4.14) = 6.8862E+007
u = su (4.1) = 1.7004869E-005
-----

Calculation of ratio lb/ld
-----

Lap Length: lb/ld = 0.19435406
lb = 300.00
ld = 1543.575
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 14.46154
Mean strength value of all re-bars: fy = 694.45
    t = 1.18462
    s = 0.80
    e = 1.00
    cb = 25.00
    Ktr = 3.22215
    n = 13.00
-----

Calculation of Mu2+
-----

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.7004869E-005
Mu = 6.8862E+007
-----

with full section properties:
b = 400.00

```

$d = 258.00$
 $d' = 42.00$
 $v = 5.6011789E-005$
 $N = 190.7537$
 $fc = 33.00$
 $co (5A.5, TBDY) = 0.002$
Final value of cu : $cu^* = shear_factor * Max(cu, cc) = 0.00721688$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $cu = 0.00721688$
 $we (5.4c) = 0.00863449$
 $ase ((5.4d), TBDY) = 0.15672608$
 $bo = 240.00$
 $ho = 340.00$
 $bi2 = 346400.00$
 $psh,min = Min(psh,x, psh,y) = 0.00261799$

$psh,x (5.4d) = 0.00349066$
 $Ash = Astir*ns = 78.53982$
No stirups, $ns = 2.00$
 $bk = 300.00$

$psh,y (5.4d) = 0.00261799$
 $Ash = Astir*ns = 78.53982$
No stirups, $ns = 2.00$
 $bk = 400.00$

$s = 150.00$
 $fywe = 694.45$
 $fce = 33.00$
From ((5.A5), TBDY), TBDY: $cc = 0.00262167$
 $c = confinement\ factor = 1.06217$
 $y1 = 0.00104853$
 $sh1 = 0.00335528$
 $ft1 = 349.5114$
 $fy1 = 291.2595$
 $su1 = 0.00335528$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $lo/lou,min = lb/ld = 0.19435406$
 $su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esu1_nominal = 0.08$,
For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs1 = fs = 291.2595$
with $Es1 = Es = 200000.00$
 $y2 = 0.00104853$
 $sh2 = 0.00335528$
 $ft2 = 349.5114$
 $fy2 = 291.2595$
 $su2 = 0.00335528$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $lo/lou,min = lb/lb,min = 0.19435406$
 $su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esu2_nominal = 0.08$,
For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs2 = fs = 291.2595$
with $Es2 = Es = 200000.00$
 $yv = 0.00104853$
 $shv = 0.00335528$
 $ftv = 349.5114$
 $fyv = 291.2595$

```

suv = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lo,min = lb/ld = 0.19435406
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 291.2595
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06985696
2 = Asl,com/(b*d)*(fs2/fc) = 0.06985696
v = Asl,mid/(b*d)*(fsv/fc) = 0.04352626
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 35.05152
cc (5A.5, TBDY) = 0.00262167
c = confinement factor = 1.06217
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09299842
2 = Asl,com/(b*d)*(fs2/fc) = 0.09299842
v = Asl,mid/(b*d)*(fsv/fc) = 0.05794517
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.23522079
Mu = MRc (4.14) = 6.8862E+007
u = su (4.1) = 1.7004869E-005

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.19435406
lb = 300.00
ld = 1543.575
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 14.46154
Mean strength value of all re-bars: fy = 694.45
t = 1.18462
s = 0.80
e = 1.00
cb = 25.00
Ktr = 3.22215
n = 13.00

```

Calculation of Mu2-

```

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.7004869E-005
Mu = 6.8862E+007

```

with full section properties:

```

b = 400.00
d = 258.00
d' = 42.00

```

```

v = 5.6011789E-005
N = 190.7537
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00721688
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00721688
we (5.4c) = 0.00863449
ase ((5.4d), TBDY) = 0.15672608
bo = 240.00
ho = 340.00
bi2 = 346400.00
psh,min = Min(psh,x , psh,y) = 0.00261799
-----
psh,x (5.4d) = 0.00349066
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 300.00
-----
psh,y (5.4d) = 0.00261799
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
-----
s = 150.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00262167
c = confinement factor = 1.06217
y1 = 0.00104853
sh1 = 0.00335528
ft1 = 349.5114
fy1 = 291.2595
su1 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.19435406
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 = 291.2595
with Es1 = Es = 200000.00
y2 = 0.00104853
sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.19435406
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 = 291.2595
with Es2 = Es = 200000.00
yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

```

and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.19435406$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv,ftv,fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 291.2595$
 with $Esv = Es = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.06985696$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.06985696$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.04352626$

and confined core properties:

$b = 340.00$
 $d = 228.00$
 $d' = 12.00$
 $fcc (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.09299842$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.09299842$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.05794517$

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

--->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.23522079$
 $Mu = MRc (4.14) = 6.8862E+007$
 $u = su (4.1) = 1.7004869E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$
 $l_b = 300.00$
 $l_d = 1543.575$
 Calculation of l_b,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 14.46154$
 Mean strength value of all re-bars: $fy = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 3.22215$
 $n = 13.00$

Calculation of Shear Strength $Vr = Min(Vr1,Vr2) = 192957.075$

Calculation of Shear Strength at edge 1, $Vr1 = 192957.075$
 $Vr1 = Vn ((22.5.1.1), ACI 318-14)$

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

From Table (22.5.5.1), ACI 318-14: $Vc = 88236.482$
 $= 1$ (normal-weight concrete)
 $fc' = 33.00$, but $fc'^{0.5} \leq 8.3 \text{ MPa}$ (22.5.3.1, ACI 318-14)
 $pw = As/(bw*d) = 0.00949023$
 As (tension reinf.) = 911.0619

$bw = 400.00$
 $d = 240.00$
 $Vu \cdot d / Mu < 1 = 0.00$
 $Mu = 9.6361865E-012$
 $Vu = 2.7041243E-015$
 From (11.5.4.8), ACI 318-14: $Vs = 104720.593$
 $Av = 157079.633$
 $fy = 555.56$
 $s = 150.00$
 Vs has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17, 10.3.4)
 $2(1-s/d) = 0.75$
 $Vf ((11-3)-(11.4), ACI 440) = 0.00$
 From (11-11), ACI 440: $Vs + Vf \leq 366348.956$

Calculation of Shear Strength at edge 2, $Vr2 = 192957.075$
 $Vr2 = Vn ((22.5.1.1), ACI 318-14)$

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 (22.5.5.1), ACI 318-14: $Vc = 88236.482$
 $= 1$ (normal-weight concrete)
 $fc' = 33.00$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $pw = As / (bw \cdot d) = 0.00949023$
 As (tension reinf.) = 911.0619
 $bw = 400.00$
 $d = 240.00$
 $Vu \cdot d / Mu < 1 = 0.00$
 $Mu = 4.6338743E-012$
 $Vu = 2.7041243E-015$
 From (11.5.4.8), ACI 318-14: $Vs = 104720.593$
 $Av = 157079.633$
 $fy = 555.56$
 $s = 150.00$
 Vs has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17, 10.3.4)
 $2(1-s/d) = 0.75$
 $Vf ((11-3)-(11.4), ACI 440) = 0.00$
 From (11-11), ACI 440: $Vs + Vf \leq 366348.956$

End Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1
 At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam B1 of floor 1

At local axis: 2
 Integration Section: (b)
 Section Type: rcars

Constant Properties

Knowledge Factor, $= 1.00$
 Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
 Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
 Consequently:
 New material of Secondary Member: Concrete Strength, $fc = f_{cm} = 33.00$
 New material of Secondary Member: Steel Strength, $fs = f_{sm} = 555.56$
 Concrete Elasticity, $Ec = 26999.444$
 Steel Elasticity, $Es = 200000.00$
 Section Height, $H = 400.00$
 Section Width, $W = 300.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 1850.00$
 Secondary Member
 Smooth Bars
 Ductile Steel

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

Stepwise Properties

Bending Moment, $M = 6.9394E+006$
Shear Force, $V_2 = 6.0183003E-014$
Shear Force, $V_3 = 10211.784$
Axial Force, $F = -612.5536$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_t = 923.6282$
-Compression: $As_c = 1218.938$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{t,ten} = 923.6282$
-Compression: $As_{c,com} = 911.0619$
-Middle: $As_{c,mid} = 307.8761$
Mean Diameter of Tension Reinforcement, $Db_L = 14.00$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.00654641$
 $u = y + p = 0.00654641$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00154641$ ((4.29), Biskinis Phd))
 $M_y = 8.8475E+007$
 $L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 679.5492
From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 1.2960E+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 5.2905043E-006$
with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b / l_d)^{2/3}) = 270.3814$
 $d = 358.00$
 $y = 0.28621627$
 $A = 0.0199705$
 $B = 0.01124535$
with $p_t = 0.00859989$
 $p_c = 0.00848289$
 $p_v = 0.00286663$
 $N = 612.5536$
 $b = 300.00$
 $" = 0.12011173$
 $y_{comp} = 2.1485644E-005$
with $f_c = 33.00$
 $E_c = 26999.444$
 $y = 0.28602252$
 $A = 0.01993644$
 $B = 0.01122426$
with $E_s = 200000.00$

Calculation of ratio l_b / l_d

Lap Length: $l_d / l_{d,min} = 0.24294258$

$l_b = 300.00$
 $l_d = 1234.86$
 Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
 $= 1$
 $db = 14.46154$
 Mean strength value of all re-bars: $f_y = 555.56$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

- Calculation of p -

From table 10-7: $p = 0.005$

with:

- Condition iv occurred
Beam controlled by inadequate embedment into beam-column joint:
($l_b/l_d < 1$ and With Lapping in the Vicinity of the End Regions)
- Condition i occurred
Beam controlled by flexure: $V_p/V_o \leq 1$
shear control ratio $V_p/V_o = 0.39885187$
- Transverse Reinforcement: NC
- Stirrup Spacing $> d/3$
- Low ductility demand, $\gamma < 2$ (table 10-6, ASCE 41-17)
 $= 2.7479450E-005$
- Stirrup Spacing $\leq d/2$
 $d = 358.00$
 $s = 150.00$
- Strength provided by hoops $V_s < 3/4 \times \text{design Shear}$
 $V_s = 186169.943$, already given in calculation of shear control ratio
 design Shear = 10211.784
- ($\rho_t - \rho_c$)/ $\rho_{bal} = -0.16136132$
 $\rho_t = A_{st}/(b_w \times d) = 0.00859989$
 Tension Reinf Area: $A_{st} = 923.6282$
 $\rho_c = A_{sc}/(b_w \times d) = 0.01134952$
 Compression Reinf Area: $A_{sc} = 1218.938$
- From (B-1), ACI 318-11: $\rho_{bal} = 0.01704017$
 $f_c = 33.00$
 $f_y = 555.56$
 From 10.2.7.3, ACI 318-11: $\lambda = 0.65$
 From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000/(87000 + f_y) = cb/dt = 0.003/(0.003 + \gamma) = 0.51922877$
 $\gamma = 0.0027778$
- $V/(b_w \times d \times f_c^{0.5}) = 0.19932585$, NOTE: units in l_b & in
 $b_w = 300.00$

End Of Calculation of Chord Rotation Capacity for element: beam B1 of floor 1

At local axis: 2

Integration Section: (b)

Calculation No. 7

beam B1, Floor 1

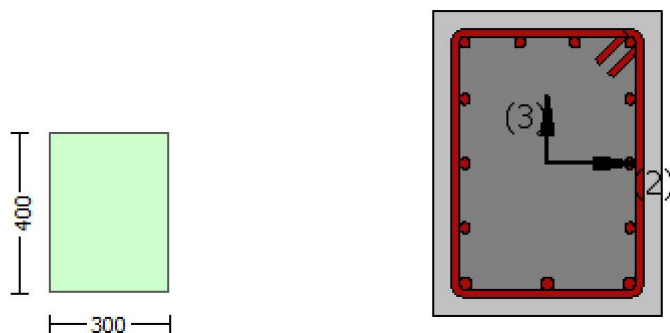
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: beam B1 of floor 1

At local axis: 3

Integration Section: (b)

Section Type: rcars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

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

Consequently:

New material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 1850.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = l_b = 300.00$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 6.8260E+006$

Shear Force, $V_a = -4669.742$

EDGE -B-

Bending Moment, $M_b = 6.9394E+006$

Shear Force, $V_b = 10211.784$

BOTH EDGES

Axial Force, $F = -612.5536$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{sl,t} = 923.6282$
-Compression: $A_{sl,c} = 1218.938$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten} = 923.6282$
-Compression: $A_{sl,com} = 911.0619$
-Middle: $A_{sl,mid} = 307.8761$
Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 14.00$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 251745.536$
 V_n ((22.5.1.1), ACI 318-14) = 251745.536

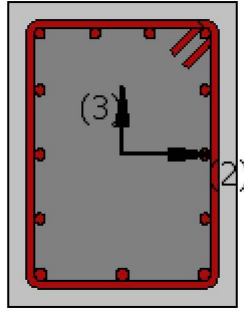
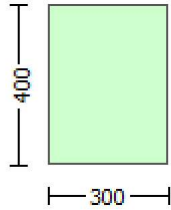
NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 84193.928$
= 1 (normal-weight concrete)
 $f_c' = 25.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00962113$
 A_s (tension reinf.) = 923.6282
 $b_w = 300.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 0.47090045$
 $M_u = 6.9394E+006$
 $V_u = 10211.784$
From (11.5.4.8), ACI 318-14: $V_s = 167551.608$
 $A_v = 157079.633$
 $f_y = 500.00$
 $s = 150.00$
 V_s 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: $V_s + V_f \leq 318865.838$

End Of Calculation of Shear Capacity for element: beam B1 of floor 1
At local axis: 3
Integration Section: (b)

Calculation No. 8

beam B1, Floor 1
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)
Analysis: Uniform +X
Check: Chord rotation capacity (ϕ_r)
Edge: End
Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

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

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

#####

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.06217

Element Length, $L = 1850.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = 300.00$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 2771.022$

EDGE -B-

Shear Force, $V_b = 2771.021$

BOTH EDGES

Axial Force, $F = -190.7537$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_{lt} = 911.0619$

-Compression: $As_{lc} = 1231.504$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{l,ten} = 911.0619$

-Compression: $As_{l,com} = 923.6282$

-Middle: $As_{l,mid} = 307.8761$

Calculation of Shear Capacity ratio , $V_e/V_r = 0.39885187$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 115624.954$
 with
 $M_{pr1} = \text{Max}(\mu_{1+}, \mu_{1-}) = 1.0444\text{E}+008$
 $\mu_{1+} = 1.0296\text{E}+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
 which is defined for the static loading combination
 $\mu_{1-} = 1.0444\text{E}+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment
 direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(\mu_{2+}, \mu_{2-}) = 1.0434\text{E}+008$
 $\mu_{2+} = 1.0305\text{E}+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
 which is defined for the the static loading combination
 $\mu_{2-} = 1.0434\text{E}+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment
 direction which is defined for the the static loading combination
 and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
 with
 $V_1 = 2771.022$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 2771.021$, is the shear force acting at edge 2 for the the static loading combination

 Calculation of μ_{1+}

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

$\mu = 1.2093195\text{E}-005$

$\mu_u = 1.0296\text{E}+008$

with full section properties:

$b = 300.00$

$d = 357.00$

$d' = 42.00$

$v = 5.3972144\text{E}-005$

$N = 190.7537$

$f_c = 33.00$

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

Final value of ϕ_{cu} : $\phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00721688$

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

From (5.4b), TB DY: $\phi_{cu} = 0.00721688$

$\phi_{we} (5.4c) = 0.00863449$

$\phi_{ase} ((5.4d), \text{TB DY}) = 0.15672608$

$b_o = 240.00$

$h_o = 340.00$

$b_i^2 = 346400.00$

$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00261799$

$\phi_{sh,x} (5.4d) = 0.00349066$

$A_{sh} = A_{stir} \cdot n_s = 78.53982$

No stirups, $n_s = 2.00$

$b_k = 300.00$

$\phi_{sh,y} (5.4d) = 0.00261799$

$A_{sh} = A_{stir} \cdot n_s = 78.53982$

No stirups, $n_s = 2.00$

$b_k = 400.00$

$s = 150.00$

$f_{ywe} = 694.45$

$f_{ce} = 33.00$

From ((5.A5), TB DY), TB DY: $\phi_{cc} = 0.00262167$

$c = \text{confinement factor} = 1.06217$

$y_1 = 0.00104853$

$sh_1 = 0.00335528$

$f_{t1} = 349.5114$

$f_{y1} = 291.2595$

```

su1 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.19435406
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb,min)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 291.2595
with Es1 = Es = 200000.00
y2 = 0.00104853
sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.19435406
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb,min)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 291.2595
with Es2 = Es = 200000.00
yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.19435406
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb,min)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 291.2595
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07508005
2 = Asl,com/(b*d)*(fs2/fc) = 0.07611563
v = Asl,mid/(b*d)*(fsv/fc) = 0.02537188
and confined core properties:
b = 240.00
d = 327.00
d' = 12.00
fcc (5A.2, TBDY) = 35.05152
cc (5A.5, TBDY) = 0.00262167
c = confinement factor = 1.06217
1 = Asl,ten/(b*d)*(fs1/fc) = 0.10246016
2 = Asl,com/(b*d)*(fs2/fc) = 0.1038734
v = Asl,mid/(b*d)*(fsv/fc) = 0.03462447
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.22282326
Mu = MRc (4.14) = 1.0296E+008
u = su (4.1) = 1.2093195E-005

```

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$l_b = 300.00$

$l_d = 1543.575$

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

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

$= 1$

$db = 14.46154$

Mean strength value of all re-bars: $f_y = 694.45$

$t = 1.18462$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 3.22215$

$n = 13.00$

Calculation of μ_1 -

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

$\mu = 1.2082259E-005$

$\mu = 1.0444E+008$

with full section properties:

$b = 300.00$

$d = 358.00$

$d' = 43.00$

$v = 5.3821384E-005$

$N = 190.7537$

$f_c = 33.00$

$\alpha = 0.002$

Final value of μ : $\mu^* = \text{shear_factor} * \text{Max}(\mu, \alpha) = 0.00721688$

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

From (5.4b), TBDY: $\mu = 0.00721688$

w_e (5.4c) = 0.00863449

a_{se} ((5.4d), TBDY) = 0.15672608

$b_o = 240.00$

$h_o = 340.00$

$b_{i2} = 346400.00$

$\mu_{sh,min} = \text{Min}(\mu_{sh,x}, \mu_{sh,y}) = 0.00261799$

$\mu_{sh,x}$ (5.4d) = 0.00349066

$A_{sh} = A_{stir} * n_s = 78.53982$

No stirrups, $n_s = 2.00$

$b_k = 300.00$

$\mu_{sh,y}$ (5.4d) = 0.00261799

$A_{sh} = A_{stir} * n_s = 78.53982$

No stirrups, $n_s = 2.00$

$b_k = 400.00$

$s = 150.00$

$f_{ywe} = 694.45$

$f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY: $\alpha = 0.00262167$

$\alpha = \text{confinement factor} = 1.06217$

$y_1 = 0.00104853$

$sh_1 = 0.00335528$

$f_{t1} = 349.5114$

$f_{y1} = 291.2595$

$su_1 = 0.00335528$

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

and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.19435406$
 $su_1 = 0.4 * esu_{1,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{1,nominal} = 0.08$,
 For calculation of $esu_{1,nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = fs = 291.2595$
 with $Es_1 = Es = 200000.00$
 $y_2 = 0.00104853$
 $sh_2 = 0.00335528$
 $ft_2 = 349.5114$
 $fy_2 = 291.2595$
 $su_2 = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.19435406$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 291.2595$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00104853$
 $sh_v = 0.00335528$
 $ft_v = 349.5114$
 $fy_v = 291.2595$
 $suv = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.19435406$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 291.2595$
 with $Esv = Es = 200000.00$
 $1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.07590302$
 $2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.07487033$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.02530101$
 and confined core properties:
 $b = 240.00$
 $d = 328.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.10355671$
 $2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.10214778$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.0345189$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.22429266$
 $Mu = MRc (4.14) = 1.0444E+008$
 $u = su (4.1) = 1.2082259E-005$

 Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$l_b = 300.00$

$l_d = 1543.575$

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

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

$= 1$

$db = 14.46154$

Mean strength value of all re-bars: $f_y = 694.45$

$t = 1.18462$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 3.22215$

$n = 13.00$

Calculation of μ_{2+}

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

$\mu = 1.2065709E-005$

$\mu = 1.0305E+008$

with full section properties:

$b = 300.00$

$d = 358.00$

$d' = 43.00$

$v = 5.3821384E-005$

$N = 190.7537$

$f_c = 33.00$

α (5A.5, TBDY) = 0.002

Final value of μ : $\mu^* = \text{shear_factor} * \text{Max}(\mu, \mu_c) = 0.00721688$

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

From (5.4b), TBDY: $\mu = 0.00721688$

w_e (5.4c) = 0.00863449

a_{se} ((5.4d), TBDY) = 0.15672608

$b_o = 240.00$

$h_o = 340.00$

$b_{i2} = 346400.00$

$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00261799$

$p_{sh,x}$ (5.4d) = 0.00349066

$A_{sh} = A_{stir} * n_s = 78.53982$

No stirrups, $n_s = 2.00$

$b_k = 300.00$

$p_{sh,y}$ (5.4d) = 0.00261799

$A_{sh} = A_{stir} * n_s = 78.53982$

No stirrups, $n_s = 2.00$

$b_k = 400.00$

$s = 150.00$

$f_{ywe} = 694.45$

$f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY: $\mu_c = 0.00262167$

c = confinement factor = 1.06217

$y_1 = 0.00104853$

$sh_1 = 0.00335528$

$ft_1 = 349.5114$

$fy_1 = 291.2595$

$su_1 = 0.00335528$

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

```

lo/lou,min = lb/d = 0.19435406
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 = 291.2595
with Es1 = Es = 200000.00
y2 = 0.00104853
sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.19435406
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 = 291.2595
with Es2 = Es = 200000.00
yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 0.19435406
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 = 291.2595
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07487033
2 = Asl,com/(b*d)*(fs2/fc) = 0.07590302
v = Asl,mid/(b*d)*(fsv/fc) = 0.02530101

```

and confined core properties:

```

b = 240.00
d = 328.00
d' = 13.00
fcc (5A.2, TBDY) = 35.05152
cc (5A.5, TBDY) = 0.00262167
c = confinement factor = 1.06217
1 = Asl,ten/(b*d)*(fs1/fc) = 0.10214778
2 = Asl,com/(b*d)*(fs2/fc) = 0.10355671
v = Asl,mid/(b*d)*(fsv/fc) = 0.0345189

```

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

```

su (4.9) = 0.22322862
Mu = MRc (4.14) = 1.0305E+008
u = su (4.1) = 1.2065709E-005

```

Calculation of ratio lb/d

Lap Length: lb/d = 0.19435406

$l_b = 300.00$
 $l_d = 1543.575$
 Calculation of l_b , min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d , min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 14.46154$
 Mean strength value of all re-bars: $f_y = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

Calculation of μ_2 -

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:
 $\mu = 1.2109886E-005$
 $\mu_u = 1.0434E+008$

with full section properties:

$b = 300.00$
 $d = 357.00$
 $d' = 42.00$
 $v = 5.3972144E-005$
 $N = 190.7537$
 $f_c = 33.00$
 α_1 (5A.5, TBDY) = 0.002
 Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.00721688$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\mu_u = 0.00721688$
 μ_{ue} (5.4c) = 0.00863449
 α_{se} ((5.4d), TBDY) = 0.15672608
 $b_o = 240.00$
 $h_o = 340.00$
 $b_{i2} = 346400.00$
 $\mu_{sh,min} = \text{Min}(\mu_{sh,x}, \mu_{sh,y}) = 0.00261799$

$\mu_{sh,x}$ (5.4d) = 0.00349066
 $A_{sh} = A_{stir} * n_s = 78.53982$
 No stirups, $n_s = 2.00$
 $b_k = 300.00$

$\mu_{sh,y}$ (5.4d) = 0.00261799
 $A_{sh} = A_{stir} * n_s = 78.53982$
 No stirups, $n_s = 2.00$
 $b_k = 400.00$

$s = 150.00$
 $f_{ywe} = 694.45$
 $f_{ce} = 33.00$
 From ((5.A5), TBDY), TBDY: $\mu_c = 0.00262167$
 c = confinement factor = 1.06217
 $y_1 = 0.00104853$
 $sh_1 = 0.00335528$
 $f_{t1} = 349.5114$
 $f_{y1} = 291.2595$
 $su_1 = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.19435406$
 $su_1 = 0.4 * esu_{1_nominal}$ ((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 $fs1 = fs = 291.2595$
with $Es1 = Es = 200000.00$
 $y2 = 0.00104853$
 $sh2 = 0.00335528$
 $ft2 = 349.5114$
 $fy2 = 291.2595$
 $su2 = 0.00335528$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $lo/lou, min = lb/lb, min = 0.19435406$
 $su2 = 0.4 \cdot esu2_nominal \cdot ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esu2_nominal = 0.08$,
For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs2 = fs = 291.2595$
with $Es2 = Es = 200000.00$
 $yv = 0.00104853$
 $shv = 0.00335528$
 $ftv = 349.5114$
 $fyv = 291.2595$
 $suv = 0.00335528$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $lo/lou, min = lb/ld = 0.19435406$
 $suv = 0.4 \cdot esuv_nominal \cdot ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esuv_nominal = 0.08$,
considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fsv = fs = 291.2595$
with $Esv = Es = 200000.00$
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.07611563$
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.07508005$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.02537188$

and confined core properties:

$b = 240.00$
 $d = 327.00$
 $d' = 12.00$
 $fcc \text{ (5A.2, TBDY)} = 35.05152$
 $cc \text{ (5A.5, TBDY)} = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.1038734$
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.10246016$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.03462447$

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

--->

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

--->

$su \text{ (4.9)} = 0.22389443$
 $Mu = MRc \text{ (4.14)} = 1.0434E+008$
 $u = su \text{ (4.1)} = 1.2109886E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.19435406$
 $lb = 300.00$
 $ld = 1543.575$

Calculation of $I_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $I_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 14.46154$
Mean strength value of all re-bars: $f_y = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 289894.477$

Calculation of Shear Strength at edge 1, $V_{r1} = 289894.477$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14: $V_c = 103724.534$
 $= 1$ (normal-weight concrete)
 $f_c' = 33.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $pw = A_s / (bw \cdot d) = 0.00949023$
 A_s (tension reinf.) = 911.0619
 $bw = 300.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 1.00$
 $M_u = 71454.459$
 $V_u = 2771.022$

From (11.5.4.8), ACI 318-14: $V_s = 186169.943$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$

V_s 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: $V_s + V_f \leq 366348.956$

Calculation of Shear Strength at edge 2, $V_{r2} = 289894.477$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14: $V_c = 103724.534$
 $= 1$ (normal-weight concrete)
 $f_c' = 33.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $pw = A_s / (bw \cdot d) = 0.00949023$
 A_s (tension reinf.) = 911.0619
 $bw = 300.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 1.00$
 $M_u = 71455.367$
 $V_u = 2771.021$

From (11.5.4.8), ACI 318-14: $V_s = 186169.943$

$A_v = 157079.633$

$f_y = 555.56$

$s = 150.00$

V_s 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: $V_s + V_f \leq 366348.956$

End Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

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

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

#####

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.06217

Element Length, $L = 1850.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = 300.00$

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = -2.7041243E-015$

EDGE -B-

Shear Force, $V_b = 2.7041243E-015$

BOTH EDGES

Axial Force, $F = -190.7537$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 911.0619$

-Compression: $As_c = 1231.504$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 816.8141$

-Compression: $As_{c,com} = 816.8141$

-Middle: $As_{mid} = 508.938$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.38581165$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 74445.088$
with

$M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 6.8862E+007$

$Mu_{1+} = 6.8862E+007$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination

$Mu_{1-} = 6.8862E+007$, 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

$M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 6.8862E+007$

$Mu_{2+} = 6.8862E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination

$Mu_{2-} = 6.8862E+007$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
and

$$\pm wu*ln = (|V1| + |V2|)/2$$

with

$V1 = -2.7041243E-015$, is the shear force acting at edge 1 for the static loading combination

$V2 = 2.7041243E-015$, is the shear force acting at edge 2 for the static loading combination

Calculation of Mu_{1+}

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

$$u = 1.7004869E-005$$

$$Mu = 6.8862E+007$$

with full section properties:

$$b = 400.00$$

$$d = 258.00$$

$$d' = 42.00$$

$$v = 5.6011789E-005$$

$$N = 190.7537$$

$$fc = 33.00$$

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

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00721688$$

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

$$\text{From (5.4b), TBDY: } cu = 0.00721688$$

$$we(5.4c) = 0.00863449$$

$$ase((5.4d), TBDY) = 0.15672608$$

$$bo = 240.00$$

$$ho = 340.00$$

$$bi2 = 346400.00$$

$$psh, \min = \text{Min}(psh, x, psh, y) = 0.00261799$$

$$psh, x(5.4d) = 0.00349066$$

$$Ash = Astir * ns = 78.53982$$

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

$$bk = 300.00$$

$$psh, y(5.4d) = 0.00261799$$

$$Ash = Astir * ns = 78.53982$$

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

$$bk = 400.00$$

$$s = 150.00$$

$$fywe = 694.45$$

$$fce = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.00262167$$

$$c = \text{confinement factor} = 1.06217$$

$$y1 = 0.00104853$$

$$sh1 = 0.00335528$$

$$ft1 = 349.5114$$

$$fy1 = 291.2595$$

$$su1 = 0.00335528$$

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

and also multiplied by the shear_factor according to 15.7.1.4, with

$$\text{Shear_factor} = 1.00$$

$$lo/lo, \min = lb/d = 0.19435406$$

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

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

For calculation of $esu1_{\text{nominal}}$ and $y1, sh1, ft1, fy1$, it is considered

characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

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

$$\text{with } fs1 = fs = 291.2595$$

with $E_s = E_s = 200000.00$
 $y_2 = 0.00104853$
 $sh_2 = 0.00335528$
 $ft_2 = 349.5114$
 $fy_2 = 291.2595$
 $su_2 = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lo_{min} = lb/lb_{min} = 0.19435406$
 $su_2 = 0.4 * esu_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{nominal} = 0.08$,
 For calculation of $esu_{nominal}$ 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 $fs_2 = fs = 291.2595$
 with $E_s = E_s = 200000.00$
 $y_v = 0.00104853$
 $sh_v = 0.00335528$
 $ft_v = 349.5114$
 $fy_v = 291.2595$
 $suv = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lo_{min} = lb/ld = 0.19435406$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = fs = 291.2595$
 with $E_s = E_s = 200000.00$
 $1 = Asl_{ten}/(b*d) * (fs_1/f_c) = 0.06985696$
 $2 = Asl_{com}/(b*d) * (fs_2/f_c) = 0.06985696$
 $v = Asl_{mid}/(b*d) * (fs_v/f_c) = 0.04352626$

and confined core properties:

$b = 340.00$
 $d = 228.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = Asl_{ten}/(b*d) * (fs_1/f_c) = 0.09299842$
 $2 = Asl_{com}/(b*d) * (fs_2/f_c) = 0.09299842$
 $v = Asl_{mid}/(b*d) * (fs_v/f_c) = 0.05794517$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.23522079$
 $Mu = MRc (4.14) = 6.8862E+007$
 $u = su (4.1) = 1.7004869E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.19435406$

$lb = 300.00$

$ld = 1543.575$

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

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

= 1

$db = 14.46154$

Mean strength value of all re-bars: $fy = 694.45$

t = 1.18462
s = 0.80
e = 1.00
cb = 25.00
Ktr = 3.22215
n = 13.00

Calculation of Mu1-

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

u = 1.7004869E-005
Mu = 6.8862E+007

with full section properties:

b = 400.00
d = 258.00
d' = 42.00
v = 5.6011789E-005
N = 190.7537

fc = 33.00
co (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.00721688$

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

From (5.4b), TBDY: $\phi_u = 0.00721688$

we (5.4c) = 0.00863449

ase ((5.4d), TBDY) = 0.15672608

bo = 240.00

ho = 340.00

bi2 = 346400.00

psh,min = Min(psh,x , psh,y) = 0.00261799

psh,x (5.4d) = 0.00349066

Ash = Astir*ns = 78.53982

No stirups, ns = 2.00

bk = 300.00

psh,y (5.4d) = 0.00261799

Ash = Astir*ns = 78.53982

No stirups, ns = 2.00

bk = 400.00

s = 150.00

fywe = 694.45

fce = 33.00

From ((5.A5), TBDY), TBDY: $\phi_c = 0.00262167$

c = confinement factor = 1.06217

y1 = 0.00104853

sh1 = 0.00335528

ft1 = 349.5114

fy1 = 291.2595

su1 = 0.00335528

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

lo/lou,min = lb/d = 0.19435406

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 = 291.2595

with Es1 = Es = 200000.00

y2 = 0.00104853

```

sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb,min = 0.19435406
    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 = 291.2595
    with Es2 = Es = 200000.00
yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb = 0.19435406
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = fs = 291.2595
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06985696
2 = Asl,com/(b*d)*(fs2/fc) = 0.06985696
v = Asl,mid/(b*d)*(fsv/fc) = 0.04352626
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 35.05152
cc (5A.5, TBDY) = 0.00262167
c = confinement factor = 1.06217
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09299842
2 = Asl,com/(b*d)*(fs2/fc) = 0.09299842
v = Asl,mid/(b*d)*(fsv/fc) = 0.05794517
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.23522079
Mu = MRc (4.14) = 6.8862E+007
u = su (4.1) = 1.7004869E-005

```

Calculation of ratio lb/lb

```

Lap Length: lb/lb = 0.19435406
lb = 300.00
lb = 1543.575
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
lb,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 14.46154
Mean strength value of all re-bars: fy = 694.45
t = 1.18462
s = 0.80

```

e = 1.00
cb = 25.00
Ktr = 3.22215
n = 13.00

Calculation of Mu2+

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

$\phi_u = 1.7004869E-005$
 $M_u = 6.8862E+007$

with full section properties:

b = 400.00
d = 258.00
d' = 42.00
 $\phi = 5.6011789E-005$
N = 190.7537

$f_c = 33.00$
 $\phi_{co} (5A.5, TBDY) = 0.002$

Final value of ϕ_{cu} : $\phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00721688$

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

From (5.4b), TBDY: $\phi_{cu} = 0.00721688$

$\phi_{we} (5.4c) = 0.00863449$

$\phi_{ase} ((5.4d), TBDY) = 0.15672608$

$b_o = 240.00$

$h_o = 340.00$

$b_{i2} = 346400.00$

$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.00261799$

$\phi_{psh,x} (5.4d) = 0.00349066$

Ash = Astir*ns = 78.53982

No stirrups, ns = 2.00

bk = 300.00

$\phi_{psh,y} (5.4d) = 0.00261799$

Ash = Astir*ns = 78.53982

No stirrups, ns = 2.00

bk = 400.00

s = 150.00

$f_{ywe} = 694.45$

$f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY: $\phi_{cc} = 0.00262167$

c = confinement factor = 1.06217

$y_1 = 0.00104853$

$sh_1 = 0.00335528$

$ft_1 = 349.5114$

$fy_1 = 291.2595$

$su_1 = 0.00335528$

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

$l_o/l_{ou,min} = l_b/l_d = 0.19435406$

$su_1 = 0.4 * esu1_nominal ((5.5), TBDY) = 0.032$

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

For calculation of $esu1_nominal$ and y_1, sh_1, ft_1, fy_1 , it is considered
characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.

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

with $fs_1 = fs = 291.2595$

with $Es_1 = Es = 200000.00$

$y_2 = 0.00104853$

$sh_2 = 0.00335528$

$ft_2 = 349.5114$

```

fy2 = 291.2595
su2 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.19435406
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 291.2595
with Es2 = Es = 200000.00
yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.19435406
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 291.2595
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06985696
2 = Asl,com/(b*d)*(fs2/fc) = 0.06985696
v = Asl,mid/(b*d)*(fsv/fc) = 0.04352626
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 35.05152
cc (5A.5, TBDY) = 0.00262167
c = confinement factor = 1.06217
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09299842
2 = Asl,com/(b*d)*(fs2/fc) = 0.09299842
v = Asl,mid/(b*d)*(fsv/fc) = 0.05794517

```

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

```

--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.23522079
Mu = MRc (4.14) = 6.8862E+007
u = su (4.1) = 1.7004869E-005

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.19435406
lb = 300.00
ld = 1543.575
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 14.46154
Mean strength value of all re-bars: fy = 694.45
t = 1.18462
s = 0.80
e = 1.00
cb = 25.00

```

Ktr = 3.22215
n = 13.00

Calculation of Mu2-

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

$\phi_u = 1.7004869E-005$

$M_u = 6.8862E+007$

with full section properties:

b = 400.00

d = 258.00

d' = 42.00

$\nu = 5.6011789E-005$

N = 190.7537

f_c = 33.00

c_o (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.00721688$

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

From (5.4b), TBDY: $\phi_u = 0.00721688$

ϕ_{ue} (5.4c) = 0.00863449

ϕ_{ase} ((5.4d), TBDY) = 0.15672608

b_o = 240.00

h_o = 340.00

b_{i2} = 346400.00

$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00261799$

$\phi_{sh,x}$ (5.4d) = 0.00349066

A_{sh} = A_{stir}*n_s = 78.53982

No stirups, n_s = 2.00

b_k = 300.00

$\phi_{sh,y}$ (5.4d) = 0.00261799

A_{sh} = A_{stir}*n_s = 78.53982

No stirups, n_s = 2.00

b_k = 400.00

s = 150.00

f_{ywe} = 694.45

f_{ce} = 33.00

From ((5.A5), TBDY), TBDY: $\phi_c = 0.00262167$

c = confinement factor = 1.06217

y₁ = 0.00104853

sh₁ = 0.00335528

ft₁ = 349.5114

fy₁ = 291.2595

su₁ = 0.00335528

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

l_o/l_{ou,min} = l_b/l_d = 0.19435406

su₁ = 0.4*su_{1,nominal} ((5.5), TBDY) = 0.032

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

For calculation of esu_{1,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*(l_b/l_d)^{2/3}), from 10.3.5, ASCE 41-17.

with fs₁ = fs = 291.2595

with Es₁ = Es = 200000.00

y₂ = 0.00104853

sh₂ = 0.00335528

ft₂ = 349.5114

fy₂ = 291.2595

su₂ = 0.00335528

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_{b,min} = 0.19435406$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 291.2595$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00104853$
 $sh_v = 0.00335528$
 $ft_v = 349.5114$
 $fy_v = 291.2595$
 $suv = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 0.19435406$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsy_v = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsy_v = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 291.2595$
 with $Es_v = Es = 200000.00$
 $1 = A_{sl,ten}/(b*d) * (fs_1/f_c) = 0.06985696$
 $2 = A_{sl,com}/(b*d) * (fs_2/f_c) = 0.06985696$
 $v = A_{sl,mid}/(b*d) * (fsv/f_c) = 0.04352626$
 and confined core properties:
 $b = 340.00$
 $d = 228.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = A_{sl,ten}/(b*d) * (fs_1/f_c) = 0.09299842$
 $2 = A_{sl,com}/(b*d) * (fs_2/f_c) = 0.09299842$
 $v = A_{sl,mid}/(b*d) * (fsv/f_c) = 0.05794517$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.23522079$
 $Mu = MRc (4.14) = 6.8862E+007$
 $u = su (4.1) = 1.7004869E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$
 $l_b = 300.00$
 $l_d = 1543.575$
 Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 14.46154$
 Mean strength value of all re-bars: $fy = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 192957.075$

Calculation of Shear Strength at edge 1, $V_{r1} = 192957.075$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14: $V_c = 88236.482$
= 1 (normal-weight concrete)
 $f_c' = 33.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00949023$
 A_s (tension reinf.) = 911.0619
 $b_w = 400.00$
 $d = 240.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 9.6361865E-012$
 $V_u = 2.7041243E-015$

From (11.5.4.8), ACI 318-14: $V_s = 104720.593$

$A_v = 157079.633$

$f_y = 555.56$

$s = 150.00$

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

$2(1-s/d) = 0.75$

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

From (11-11), ACI 440: $V_s + V_f \leq 366348.956$

Calculation of Shear Strength at edge 2, $V_{r2} = 192957.075$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14: $V_c = 88236.482$
= 1 (normal-weight concrete)
 $f_c' = 33.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00949023$
 A_s (tension reinf.) = 911.0619
 $b_w = 400.00$
 $d = 240.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 4.6338743E-012$
 $V_u = 2.7041243E-015$

From (11.5.4.8), ACI 318-14: $V_s = 104720.593$

$A_v = 157079.633$

$f_y = 555.56$

$s = 150.00$

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

$2(1-s/d) = 0.75$

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

From (11-11), ACI 440: $V_s + V_f \leq 366348.956$

End Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam B1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcars

Constant Properties

Knowledge Factor, $\phi = 1.00$

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

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 1850.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_b = 300.00$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = -4.8101563E-011$

Shear Force, $V_2 = 6.0183003E-014$

Shear Force, $V_3 = 10211.784$

Axial Force, $F = -612.5536$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 923.6282$

-Compression: $A_{sc} = 1218.938$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{st,ten} = 816.8141$

-Compression: $A_{st,com} = 816.8141$

-Middle: $A_{st,mid} = 508.938$

Mean Diameter of Tension Reinforcement, $D_bL = 14.40$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.00756399$

$u = y + p = 0.00756399$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00256399$ ((4.29), Biskinis Phd))

$M_y = 6.0620E+007$

$L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 925.00

From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 7.2898E+012$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

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

$y_{ten} = 7.4477525E-006$

with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b/d)^{2/3}) = 270.3814$

$d = 258.00$

$y = 0.29643893$

$A = 0.02078325$

$B = 0.01209248$

with $p_t = 0.00791487$

$p_c = 0.00791487$

$p_v = 0.00493157$
 $N = 612.5536$
 $b = 400.00$
 $" = 0.1627907$
 $y_{comp} = 2.8784108E-005$
 with $f_c = 33.00$
 $E_c = 26999.444$
 $y = 0.29625053$
 $A = 0.02074781$
 $B = 0.01207052$
 with $E_s = 200000.00$

Calculation of ratio l_b/l_d

Lap Length: $l_d/l_{d,min} = 0.24294258$
 $l_b = 300.00$
 $l_d = 1234.86$
 Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
 $= 1$
 $db = 14.46154$
 Mean strength value of all re-bars: $f_y = 555.56$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

- Calculation of p -

From table 10-7: $p = 0.005$

with:

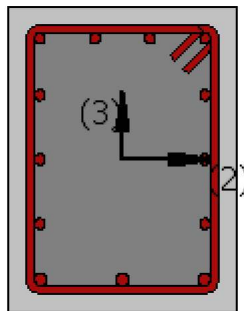
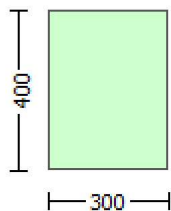
- Condition iv occurred
Beam controlled by inadequate embedment into beam-column joint:
($l_b/l_d < 1$ and With Lapping in the Vicinity of the End Regions)
- Condition i occurred
Beam controlled by flexure: $V_p/V_o \leq 1$
shear control ratio $V_p/V_o = 0.38581165$
- Transverse Reinforcement: NC
- Stirrup Spacing $> d/3$
- Low ductility demand, $\gamma < 2$ (table 10-6, ASCE 41-17)
 $= -1.6736352E-021$
- Stirrup Spacing $> d/2$
 $d = 258.00$
 $s = 150.00$
- Strength provided by hoops $V_s < 3/4 \times \text{design Shear}$
 $V_s = 139627.457$, already given in calculation of shear control ratio
design Shear = $6.0183003E-014$
- ($\rho_t - \rho_c$)/ $\rho_{bal} = -0.16792835$
 $\rho_t = A_{st}/(b_w \times d) = 0.00894989$
 Tension Reinf Area: $A_{st} = 923.6282$
 $\rho_c = A_{sc}/(b_w \times d) = 0.01181141$
 Compression Reinf Area: $A_{sc} = 1218.938$
 From (B-1), ACI 318-11: $\rho_{bal} = 0.01704017$
 $f_c = 33.00$
 $f_y = 555.56$
 From 10.2.7.3, ACI 318-11: $\rho_t = 0.65$
 From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000/(87000 + f_y) = cb/dt = 0.003/(0.003 + \rho_t) = 0.51922877$
 $\rho_t = 0.0027778$
- $V/(b_w \times d \times f_c^{0.5}) = 1.2225325E-018$, NOTE: units in lb & in
 $b_w = 400.00$

End Of Calculation of Chord Rotation Capacity for element: beam B1 of floor 1

At local axis: 3
Integration Section: (b)

Calculation No. 9

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



Start Of Calculation of Shear Capacity for element: beam B1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcars

Constant Properties

Knowledge Factor, $\gamma = 1.00$
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
New material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$
New material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$
Section Height, $H = 400.00$
Section Width, $W = 300.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 1850.00$
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_o = l_b = 300.00$
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, $M_a = -7.4560473E-011$
Shear Force, $V_a = -7.2286192E-014$
EDGE -B-
Bending Moment, $M_b = -5.9205937E-011$
Shear Force, $V_b = 7.2286192E-014$
BOTH EDGES
Axial Force, $F = -701.3709$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 911.0619$
-Compression: $A_{sc} = 1231.504$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten} = 816.8141$
-Compression: $A_{sc,com} = 816.8141$
-Middle: $A_{st,mid} = 508.938$
Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 14.40$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 171047.78$
 V_n ((22.5.1.1), ACI 318-14) = 171047.78

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

From Table (22.5.5.1), ACI 318-14: $V_c = 76800.00$
= 1 (normal-weight concrete)
 $f_c' = 25.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s/(b_w \cdot d) = 0.00949023$
 A_s (tension reinf.) = 911.0619
 $b_w = 400.00$
 $d = 240.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 7.4560473E-011$
 $V_u = 7.2286192E-014$
From (11.5.4.8), ACI 318-14: $V_s = 94247.78$
 $A_v = 157079.633$
 $f_y = 500.00$
 $s = 150.00$
 V_s has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17, 10.3.4)
 $2(1-s/d) = 0.75$
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 318865.838$

End Of Calculation of Shear Capacity for element: beam B1 of floor 1
At local axis: 2
Integration Section: (a)

beam B1, Floor 1

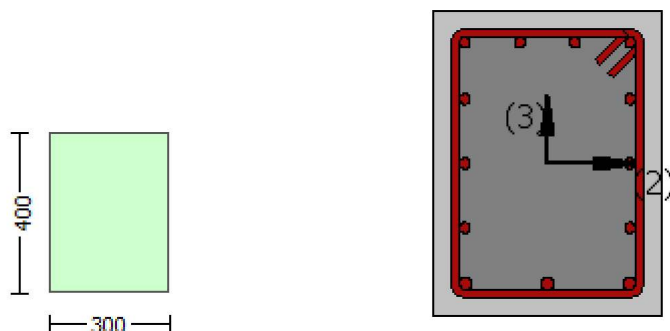
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (μ)

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

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

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

#####

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.06217

Element Length, $L = 1850.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = 300.00$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 2771.022$

EDGE -B-

Shear Force, $V_b = 2771.021$
 BOTH EDGES
 Axial Force, $F = -190.7537$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 911.0619$
 -Compression: $As_c = 1231.504$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 911.0619$
 -Compression: $As_{c,com} = 923.6282$
 -Middle: $As_{mid} = 307.8761$

 Calculation of Shear Capacity ratio, $V_e/V_r = 0.39885187$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 115624.954$
 with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 1.0444\text{E}+008$
 $\mu_{u1+} = 1.0296\text{E}+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
 which is defined for the static loading combination
 $\mu_{u1-} = 1.0444\text{E}+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment
 direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 1.0434\text{E}+008$
 $\mu_{u2+} = 1.0305\text{E}+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
 which is defined for the the static loading combination
 $\mu_{u2-} = 1.0434\text{E}+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment
 direction which is defined for the the static loading combination
 and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
 with
 $V_1 = 2771.022$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 2771.021$, is the shear force acting at edge 2 for the the static loading combination

 Calculation of μ_{u1+}

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

$\phi_u = 1.2093195\text{E}-005$
 $\mu_u = 1.0296\text{E}+008$

 with full section properties:

$b = 300.00$
 $d = 357.00$
 $d' = 42.00$
 $v = 5.3972144\text{E}-005$
 $N = 190.7537$
 $f_c = 33.00$
 $\phi_{co} (5A.5, \text{TBDY}) = 0.002$
 Final value of ϕ_{cu} : $\phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00721688$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\phi_{cu} = 0.00721688$
 $\phi_{we} (5.4c) = 0.00863449$
 $\phi_{ase} ((5.4d), \text{TBDY}) = 0.15672608$
 $b_o = 240.00$
 $h_o = 340.00$
 $b_{i2} = 346400.00$
 $\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.00261799$

 $\phi_{psh,x} (5.4d) = 0.00349066$
 $A_{sh} = A_{stir} \cdot n_s = 78.53982$
 No stirups, $n_s = 2.00$
 $b_k = 300.00$

 $\phi_{psh,y} (5.4d) = 0.00261799$

$$Ash = Astir * ns = 78.53982$$

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

$$bk = 400.00$$

$$s = 150.00$$

$$fywe = 694.45$$

$$fce = 33.00$$

$$\text{From } ((5.5), \text{TDY}), \text{TDY: } cc = 0.00262167$$

$$c = \text{confinement factor} = 1.06217$$

$$y1 = 0.00104853$$

$$sh1 = 0.00335528$$

$$ft1 = 349.5114$$

$$fy1 = 291.2595$$

$$su1 = 0.00335528$$

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

$$lo/lou, \min = lb/ld = 0.19435406$$

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

From table 5A.1, TDY: 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, TDY.

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

$$\text{with } fs1 = fs = 291.2595$$

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

$$y2 = 0.00104853$$

$$sh2 = 0.00335528$$

$$ft2 = 349.5114$$

$$fy2 = 291.2595$$

$$su2 = 0.00335528$$

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

$$lo/lou, \min = lb/lb, \min = 0.19435406$$

$$su2 = 0.4 * esu2_{\text{nominal}} ((5.5), \text{TDY}) = 0.032$$

From table 5A.1, TDY: 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, TDY.

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

$$\text{with } fs2 = fs = 291.2595$$

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

$$yv = 0.00104853$$

$$shv = 0.00335528$$

$$ftv = 349.5114$$

$$fyv = 291.2595$$

$$suv = 0.00335528$$

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

$$lo/lou, \min = lb/ld = 0.19435406$$

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

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

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

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

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

$$\text{with } fsv = fs = 291.2595$$

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

$$1 = Asl, \text{ten} / (b * d) * (fs1 / fc) = 0.07508005$$

$$2 = Asl, \text{com} / (b * d) * (fs2 / fc) = 0.07611563$$

$$v = Asl, \text{mid} / (b * d) * (fsv / fc) = 0.02537188$$

and confined core properties:

$$b = 240.00$$

$$d = 327.00$$

$$d' = 12.00$$

$$fcc (5A.2, \text{TDY}) = 35.05152$$

$$cc (5A.5, \text{TDY}) = 0.00262167$$

$c = \text{confinement factor} = 1.06217$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.10246016$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.1038734$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.03462447$

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

--->

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

--->

$\mu_u(4.9) = 0.22282326$
 $\mu_u = M_{Rc}(4.14) = 1.0296E+008$
 $u = \mu_u(4.1) = 1.2093195E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$l_b = 300.00$

$l_d = 1543.575$

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

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

= 1

$db = 14.46154$

Mean strength value of all re-bars: $f_y = 694.45$

$t = 1.18462$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 3.22215$

$n = 13.00$

Calculation of μ_{u1} -

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

$u = 1.2082259E-005$

$\mu_u = 1.0444E+008$

with full section properties:

$b = 300.00$

$d = 358.00$

$d' = 43.00$

$v = 5.3821384E-005$

$N = 190.7537$

$f_c = 33.00$

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

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.00721688$

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

From (5.4b), TBDY: $\mu_u = 0.00721688$

$\mu_{ue}(5.4c) = 0.00863449$

$\mu_{ase}((5.4d), \text{TBDY}) = 0.15672608$

$b_o = 240.00$

$h_o = 340.00$

$b_{i2} = 346400.00$

$\mu_{psh,min} = \text{Min}(\mu_{psh,x}, \mu_{psh,y}) = 0.00261799$

$\mu_{psh,x}(5.4d) = 0.00349066$

$A_{sh} = A_{stir} * n_s = 78.53982$

No stirrups, $n_s = 2.00$

$b_k = 300.00$

$\mu_{psh,y}(5.4d) = 0.00261799$

$A_{sh} = A_{stir} * n_s = 78.53982$

No stirrups, $n_s = 2.00$

bk = 400.00

s = 150.00

fywe = 694.45

fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.00262167

c = confinement factor = 1.06217

y1 = 0.00104853

sh1 = 0.00335528

ft1 = 349.5114

fy1 = 291.2595

su1 = 0.00335528

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

lo/lou,min = lb/lb = 0.19435406

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 = 291.2595

with Es1 = Es = 200000.00

y2 = 0.00104853

sh2 = 0.00335528

ft2 = 349.5114

fy2 = 291.2595

su2 = 0.00335528

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

lo/lou,min = lb/lb,min = 0.19435406

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 = 291.2595

with Es2 = Es = 200000.00

yv = 0.00104853

shv = 0.00335528

ftv = 349.5114

fyv = 291.2595

suv = 0.00335528

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

lo/lou,min = lb/lb = 0.19435406

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

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

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

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

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

with fsv = fs = 291.2595

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.07590302

2 = Asl,com/(b*d)*(fs2/fc) = 0.07487033

v = Asl,mid/(b*d)*(fsv/fc) = 0.02530101

and confined core properties:

b = 240.00

d = 328.00

d' = 13.00

fcc (5A.2, TBDY) = 35.05152

cc (5A.5, TBDY) = 0.00262167

c = confinement factor = 1.06217

1 = Asl,ten/(b*d)*(fs1/fc) = 0.10355671

$$2 = A_{sl,com}/(b*d)*(f_s2/f_c) = 0.10214778$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.0345189$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$s_u(4.9) = 0.22429266$$

$$\mu_u = M_{Rc}(4.14) = 1.0444E+008$$

$$u = s_u(4.1) = 1.2082259E-005$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$$l_b = 300.00$$

$$l_d = 1543.575$$

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

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

$$= 1$$

$$d_b = 14.46154$$

Mean strength value of all re-bars: $f_y = 694.45$

$$t = 1.18462$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 3.22215$$

$$n = 13.00$$

Calculation of μ_{u2+}

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

$$u = 1.2065709E-005$$

$$\mu_u = 1.0305E+008$$

with full section properties:

$$b = 300.00$$

$$d = 358.00$$

$$d' = 43.00$$

$$v = 5.3821384E-005$$

$$N = 190.7537$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu_{cu}: \mu_{cu}^* = \text{shear_factor} * \text{Max}(\mu_{cu}, \mu_{cc}) = 0.00721688$$

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

$$\text{From (5.4b), TBDY: } \mu_{cu} = 0.00721688$$

$$\mu_{we}(5.4c) = 0.00863449$$

$$\alpha_{ase}((5.4d), TBDY) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

$$\mu_{psh,min} = \text{Min}(\mu_{psh,x}, \mu_{psh,y}) = 0.00261799$$

$$\mu_{psh,x}(5.4d) = 0.00349066$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 300.00$$

$$\mu_{psh,y}(5.4d) = 0.00261799$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 400.00$$

```

s = 150.00
fywe = 694.45
fce = 33.00
From ((5.A.5), TBDY), TBDY: cc = 0.00262167
c = confinement factor = 1.06217
y1 = 0.00104853
sh1 = 0.00335528
ft1 = 349.5114
fy1 = 291.2595
su1 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.19435406
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 291.2595
with Es1 = Es = 200000.00
y2 = 0.00104853
sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.19435406
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 291.2595
with Es2 = Es = 200000.00
yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.19435406
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 291.2595
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07487033
2 = Asl,com/(b*d)*(fs2/fc) = 0.07590302
v = Asl,mid/(b*d)*(fsv/fc) = 0.02530101
and confined core properties:
b = 240.00
d = 328.00
d' = 13.00
fcc (5A.2, TBDY) = 35.05152
cc (5A.5, TBDY) = 0.00262167
c = confinement factor = 1.06217
1 = Asl,ten/(b*d)*(fs1/fc) = 0.10214778
2 = Asl,com/(b*d)*(fs2/fc) = 0.10355671
v = Asl,mid/(b*d)*(fsv/fc) = 0.0345189

```

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

--->

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

--->

μ_u (4.9) = 0.22322862

$M_u = M_{Rc}$ (4.14) = 1.0305E+008

$u = \mu_u$ (4.1) = 1.2065709E-005

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$l_b = 300.00$

$l_d = 1543.575$

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

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

= 1

$d_b = 14.46154$

Mean strength value of all re-bars: $f_y = 694.45$

$t = 1.18462$

$s = 0.80$

$e = 1.00$

$c_b = 25.00$

$K_{tr} = 3.22215$

$n = 13.00$

Calculation of μ_u

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

$u = 1.2109886E-005$

$M_u = 1.0434E+008$

with full section properties:

$b = 300.00$

$d = 357.00$

$d' = 42.00$

$v = 5.3972144E-005$

$N = 190.7537$

$f_c = 33.00$

ϕ (5A.5, TBDY) = 0.002

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.00721688$

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

From (5.4b), TBDY: $\mu_u = 0.00721688$

μ_u (5.4c) = 0.00863449

μ_u ((5.4d), TBDY) = 0.15672608

$b_o = 240.00$

$h_o = 340.00$

$b_i^2 = 346400.00$

$\mu_{sh,min} = \text{Min}(\mu_{sh,x}, \mu_{sh,y}) = 0.00261799$

$\mu_{sh,x}$ (5.4d) = 0.00349066

$A_{sh} = A_{stir} * n_s = 78.53982$

No stirrups, $n_s = 2.00$

$b_k = 300.00$

$\mu_{sh,y}$ (5.4d) = 0.00261799

$A_{sh} = A_{stir} * n_s = 78.53982$

No stirrups, $n_s = 2.00$

$b_k = 400.00$

$s = 150.00$

$f_{ywe} = 694.45$

```

fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00262167
c = confinement factor = 1.06217
y1 = 0.00104853
sh1 = 0.00335528
ft1 = 349.5114
fy1 = 291.2595
su1 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.19435406
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 291.2595
with Es1 = Es = 200000.00
y2 = 0.00104853
sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.19435406
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 291.2595
with Es2 = Es = 200000.00
yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.19435406
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 291.2595
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07611563
2 = Asl,com/(b*d)*(fs2/fc) = 0.07508005
v = Asl,mid/(b*d)*(fsv/fc) = 0.02537188
and confined core properties:
b = 240.00
d = 327.00
d' = 12.00
fcc (5A.2, TBDY) = 35.05152
cc (5A.5, TBDY) = 0.00262167
c = confinement factor = 1.06217
1 = Asl,ten/(b*d)*(fs1/fc) = 0.1038734
2 = Asl,com/(b*d)*(fs2/fc) = 0.10246016
v = Asl,mid/(b*d)*(fsv/fc) = 0.03462447
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

```

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $\mu_u (4.9) = 0.22389443$
 $\mu_u = M_{Rc} (4.14) = 1.0434E+008$
 $u = \mu_u (4.1) = 1.2109886E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$
 $l_b = 300.00$
 $l_d = 1543.575$
 Calculation of l_b ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d ,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 14.46154$
 Mean strength value of all re-bars: $f_y = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 289894.477$

Calculation of Shear Strength at edge 1, $V_{r1} = 289894.477$
 $V_{r1} = V_n ((22.5.1.1), \text{ACI 318-14})$

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

From Table (22.5.5.1), ACI 318-14: $V_c = 103724.534$
 $= 1$ (normal-weight concrete)
 $f'_c = 33.00$, but $f_c^{0.5} \leq 8.3 \text{ MPa}$ (22.5.3.1, ACI 318-14)
 $p_w = A_s/(b_w*d) = 0.00949023$
 A_s (tension reinf.) = 911.0619
 $b_w = 300.00$
 $d = 320.00$
 $V_u*d/\mu_u < 1 = 1.00$
 $\mu_u = 71454.459$
 $V_u = 2771.022$
 From (11.5.4.8), ACI 318-14: $V_s = 186169.943$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$
 V_s has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$
 From (11-11), ACI 440: $V_s + V_f \leq 366348.956$

Calculation of Shear Strength at edge 2, $V_{r2} = 289894.477$
 $V_{r2} = V_n ((22.5.1.1), \text{ACI 318-14})$

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

From Table (22.5.5.1), ACI 318-14: $V_c = 103724.534$
 $= 1$ (normal-weight concrete)
 $f'_c = 33.00$, but $f_c^{0.5} \leq 8.3 \text{ MPa}$ (22.5.3.1, ACI 318-14)
 $p_w = A_s/(b_w*d) = 0.00949023$
 A_s (tension reinf.) = 911.0619
 $b_w = 300.00$
 $d = 320.00$

$$V_u \cdot d / M_u < 1 = 1.00$$

$$M_u = 71455.367$$

$$V_u = 2771.021$$

$$\text{From (11.5.4.8), ACI 318-14: } V_s = 186169.943$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

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

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

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 366348.956$$

End Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1

At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcars

Constant Properties

Knowledge Factor, $\phi = 1.00$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

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

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

#####

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.06217

Element Length, $L = 1850.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = 300.00$

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = -2.7041243E-015$

EDGE -B-

Shear Force, $V_b = 2.7041243E-015$

BOTH EDGES

Axial Force, $F = -190.7537$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{sl,t} = 911.0619$

-Compression: $A_{sl,c} = 1231.504$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten} = 816.8141$

-Compression: $A_{sl,com} = 816.8141$

-Middle: $A_{sl,mid} = 508.938$

Calculation of Shear Capacity ratio , $V_e/V_r = 0.38581165$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 74445.088$
with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 6.8862E+007$

$M_{u1+} = 6.8862E+007$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$M_{u1-} = 6.8862E+007$, 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

$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 6.8862E+007$

$M_{u2+} = 6.8862E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

$M_{u2-} = 6.8862E+007$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

and

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

with

$V_1 = -2.7041243E-015$, is the shear force acting at edge 1 for the the static loading combination

$V_2 = 2.7041243E-015$, is the shear force acting at edge 2 for the the static loading combination

Calculation of M_{u1+}

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

$\phi_u = 1.7004869E-005$

$M_u = 6.8862E+007$

with full section properties:

$b = 400.00$

$d = 258.00$

$d' = 42.00$

$v = 5.6011789E-005$

$N = 190.7537$

$f_c = 33.00$

ϕ_c (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00721688$

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

From (5.4b), TBDY: $\phi_u = 0.00721688$

w_e (5.4c) = 0.00863449

a_{se} ((5.4d), TBDY) = 0.15672608

$b_o = 240.00$

$h_o = 340.00$

$b_{i2} = 346400.00$

$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00261799$

$p_{sh,x}$ (5.4d) = 0.00349066

$A_{sh} = A_{stir} \cdot n_s = 78.53982$

No stirups, $n_s = 2.00$

$b_k = 300.00$

$p_{sh,y}$ (5.4d) = 0.00261799

$A_{sh} = A_{stir} \cdot n_s = 78.53982$

No stirups, $n_s = 2.00$

$b_k = 400.00$

$s = 150.00$

$f_{ywe} = 694.45$

$f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY: $\phi_c = 0.00262167$

c = confinement factor = 1.06217

$y_1 = 0.00104853$

$sh_1 = 0.00335528$

```

ft1 = 349.5114
fy1 = 291.2595
su1 = 0.00335528
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.19435406
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb,min)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs1 = fs = 291.2595
    with Es1 = Es = 200000.00
y2 = 0.00104853
sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.19435406
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb,min)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = fs = 291.2595
    with Es2 = Es = 200000.00
yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.19435406
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb,min)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = fs = 291.2595
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06985696
2 = Asl,com/(b*d)*(fs2/fc) = 0.06985696
v = Asl,mid/(b*d)*(fsv/fc) = 0.04352626
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 35.05152
cc (5A.5, TBDY) = 0.00262167
    c = confinement factor = 1.06217
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09299842
2 = Asl,com/(b*d)*(fs2/fc) = 0.09299842
v = Asl,mid/(b*d)*(fsv/fc) = 0.05794517
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.23522079
Mu = MRc (4.14) = 6.8862E+007

```


$$u = su(4.1) = 1.7004869E-005$$

Calculation of ratio l_b/d

Lap Length: $l_b/d = 0.19435406$

$$l_b = 300.00$$

$$d = 1543.575$$

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

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

$$= 1$$

$$d_b = 14.46154$$

Mean strength value of all re-bars: $f_y = 694.45$

$$t = 1.18462$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 3.22215$$

$$n = 13.00$$

Calculation of μ_1 -

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

$$u = 1.7004869E-005$$

$$\mu = 6.8862E+007$$

with full section properties:

$$b = 400.00$$

$$d = 258.00$$

$$d' = 42.00$$

$$v = 5.6011789E-005$$

$$N = 190.7537$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00721688$$

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

$$\text{From (5.4b), TB DY: } c_u = 0.00721688$$

$$w_e(5.4c) = 0.00863449$$

$$a_{se}((5.4d), \text{TB DY}) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00261799$$

$$p_{sh,x}(5.4d) = 0.00349066$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 300.00$$

$$p_{sh,y}(5.4d) = 0.00261799$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TB DY), TB DY: } c_c = 0.00262167$$

$$c = \text{confinement factor} = 1.06217$$

$$y_1 = 0.00104853$$

$$sh_1 = 0.00335528$$

$$f_{t1} = 349.5114$$

$$f_{y1} = 291.2595$$

```

su1 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.19435406
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 = 291.2595
with Es1 = Es = 200000.00
y2 = 0.00104853
sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.19435406
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 = 291.2595
with Es2 = Es = 200000.00
yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.19435406
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 291.2595
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06985696
2 = Asl,com/(b*d)*(fs2/fc) = 0.06985696
v = Asl,mid/(b*d)*(fsv/fc) = 0.04352626
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 35.05152
cc (5A.5, TBDY) = 0.00262167
c = confinement factor = 1.06217
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09299842
2 = Asl,com/(b*d)*(fs2/fc) = 0.09299842
v = Asl,mid/(b*d)*(fsv/fc) = 0.05794517
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.23522079
Mu = MRc (4.14) = 6.8862E+007
u = su (4.1) = 1.7004869E-005

```

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$l_b = 300.00$

$l_d = 1543.575$

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

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

$= 1$

$db = 14.46154$

Mean strength value of all re-bars: $f_y = 694.45$

$t = 1.18462$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 3.22215$

$n = 13.00$

Calculation of μ_{2+}

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

$\mu = 1.7004869E-005$

$\mu = 6.8862E+007$

with full section properties:

$b = 400.00$

$d = 258.00$

$d' = 42.00$

$v = 5.6011789E-005$

$N = 190.7537$

$f_c = 33.00$

α_c (5A.5, TBDY) = 0.002

Final value of μ : $\mu^* = \text{shear_factor} * \text{Max}(\mu_c, \mu_{cc}) = 0.00721688$

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

From (5.4b), TBDY: $\mu_c = 0.00721688$

μ_{cc} (5.4c) = 0.00863449

α_{se} ((5.4d), TBDY) = 0.15672608

$b_o = 240.00$

$h_o = 340.00$

$b_{i2} = 346400.00$

$\mu_{sh,min} = \text{Min}(\mu_{sh,x}, \mu_{sh,y}) = 0.00261799$

$\mu_{sh,x}$ (5.4d) = 0.00349066

$A_{sh} = A_{stir} * n_s = 78.53982$

No stirrups, $n_s = 2.00$

$b_k = 300.00$

$\mu_{sh,y}$ (5.4d) = 0.00261799

$A_{sh} = A_{stir} * n_s = 78.53982$

No stirrups, $n_s = 2.00$

$b_k = 400.00$

$s = 150.00$

$f_{ywe} = 694.45$

$f_{ce} = 33.00$

From ((5.A.5), TBDY), TBDY: $\mu_{cc} = 0.00262167$

c = confinement factor = 1.06217

$y_1 = 0.00104853$

$sh_1 = 0.00335528$

$f_{t1} = 349.5114$

$f_{y1} = 291.2595$

$su_1 = 0.00335528$

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

and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.19435406$
 $su_1 = 0.4 * esu_{1,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{1,nominal} = 0.08$,
 For calculation of $esu_{1,nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = fs = 291.2595$
 with $Es_1 = Es = 200000.00$
 $y_2 = 0.00104853$
 $sh_2 = 0.00335528$
 $ft_2 = 349.5114$
 $fy_2 = 291.2595$
 $su_2 = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.19435406$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 291.2595$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00104853$
 $sh_v = 0.00335528$
 $ft_v = 349.5114$
 $fy_v = 291.2595$
 $suv = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.19435406$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 291.2595$
 with $Esv = Es = 200000.00$
 $1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.06985696$
 $2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.06985696$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.04352626$
 and confined core properties:
 $b = 340.00$
 $d = 228.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.09299842$
 $2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.09299842$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.05794517$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.23522079$
 $Mu = MRc (4.14) = 6.8862E+007$
 $u = su (4.1) = 1.7004869E-005$

 Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$l_b = 300.00$

$l_d = 1543.575$

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

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

$= 1$

$db = 14.46154$

Mean strength value of all re-bars: $f_y = 694.45$

$t = 1.18462$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 3.22215$

$n = 13.00$

Calculation of μ_2 -

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

$\mu = 1.7004869E-005$

$\mu_u = 6.8862E+007$

with full section properties:

$b = 400.00$

$d = 258.00$

$d' = 42.00$

$v = 5.6011789E-005$

$N = 190.7537$

$f_c = 33.00$

α (5A.5, TBDY) = 0.002

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.00721688$

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

From (5.4b), TBDY: $\mu_u = 0.00721688$

μ_w (5.4c) = 0.00863449

α_{se} ((5.4d), TBDY) = 0.15672608

$b_o = 240.00$

$h_o = 340.00$

$b_{i2} = 346400.00$

$\mu_{sh,min} = \text{Min}(\mu_{sh,x}, \mu_{sh,y}) = 0.00261799$

$\mu_{sh,x}$ (5.4d) = 0.00349066

$A_{sh} = A_{stir} * n_s = 78.53982$

No stirrups, $n_s = 2.00$

$b_k = 300.00$

$\mu_{sh,y}$ (5.4d) = 0.00261799

$A_{sh} = A_{stir} * n_s = 78.53982$

No stirrups, $n_s = 2.00$

$b_k = 400.00$

$s = 150.00$

$f_{ywe} = 694.45$

$f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY: $\mu_c = 0.00262167$

c = confinement factor = 1.06217

$y_1 = 0.00104853$

$sh_1 = 0.00335528$

$ft_1 = 349.5114$

$fy_1 = 291.2595$

$su_1 = 0.00335528$

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

```

lo/lou,min = lb/d = 0.19435406
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 = 291.2595
with Es1 = Es = 200000.00
y2 = 0.00104853
sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.19435406
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 = 291.2595
with Es2 = Es = 200000.00
yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 0.19435406
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 = 291.2595
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06985696
2 = Asl,com/(b*d)*(fs2/fc) = 0.06985696
v = Asl,mid/(b*d)*(fsv/fc) = 0.04352626

```

and confined core properties:

```

b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 35.05152
cc (5A.5, TBDY) = 0.00262167
c = confinement factor = 1.06217
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09299842
2 = Asl,com/(b*d)*(fs2/fc) = 0.09299842
v = Asl,mid/(b*d)*(fsv/fc) = 0.05794517

```

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

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

---->

```

su (4.9) = 0.23522079
Mu = MRc (4.14) = 6.8862E+007
u = su (4.1) = 1.7004869E-005

```

Calculation of ratio lb/d

Lap Length: lb/d = 0.19435406

$l_b = 300.00$
 $l_d = 1543.575$
 Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 14.46154$
 Mean strength value of all re-bars: $f_y = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 192957.075$

Calculation of Shear Strength at edge 1, $V_{r1} = 192957.075$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14: $V_c = 88236.482$
 $= 1$ (normal-weight concrete)
 $f_c' = 33.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $pw = A_s/(b_w*d) = 0.00949023$
 A_s (tension reinf.) = 911.0619
 $b_w = 400.00$
 $d = 240.00$
 $V_u*d/M_u < 1 = 0.00$
 $M_u = 9.6361865E-012$
 $V_u = 2.7041243E-015$
 From (11.5.4.8), ACI 318-14: $V_s = 104720.593$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$
 V_s has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17, 10.3.4)
 $2(1-s/d) = 0.75$
 V_f ((11-3)-(11.4), ACI 440) = 0.00
 From (11-11), ACI 440: $V_s + V_f \leq 366348.956$

Calculation of Shear Strength at edge 2, $V_{r2} = 192957.075$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14: $V_c = 88236.482$
 $= 1$ (normal-weight concrete)
 $f_c' = 33.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $pw = A_s/(b_w*d) = 0.00949023$
 A_s (tension reinf.) = 911.0619
 $b_w = 400.00$
 $d = 240.00$
 $V_u*d/M_u < 1 = 0.00$
 $M_u = 4.6338743E-012$
 $V_u = 2.7041243E-015$
 From (11.5.4.8), ACI 318-14: $V_s = 104720.593$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$
 V_s has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17, 10.3.4)
 $2(1-s/d) = 0.75$
 V_f ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 366348.956$

End Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam B1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcars

Constant Properties

Knowledge Factor, $\phi = 1.00$
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$
Section Height, $H = 400.00$
Section Width, $W = 300.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 1850.00$
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_b = 300.00$
No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 8.2483E+006$
Shear Force, $V_2 = -7.2286192E-014$
Shear Force, $V_3 = -6236.526$
Axial Force, $F = -701.3709$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 911.0619$
-Compression: $A_{sc} = 1231.504$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten} = 911.0619$
-Compression: $A_{st,com} = 923.6282$
-Middle: $A_{st,mid} = 307.8761$
Mean Diameter of Tension Reinforcement, $D_bL = 15.20$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.02296739$
 $u = y + p = 0.02296739$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00296739$ ((4.29), Biskinis Phd))
 $M_y = 8.7231E+007$
 $L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 1322.575
From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 1.2960E+013$

Calculation of Yielding Moment M_y

Calculation of ρ_y and M_y according to Annex 7 -

$y = \text{Min}(y_{\text{ten}}, y_{\text{com}})$
 $y_{\text{ten}} = 5.2913486\text{E-}006$
with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25*f_y*(l_b/d)^{2/3}) = 270.3814$
 $d = 357.00$
 $y = 0.28433109$
 $A = 0.02002951$
 $B = 0.01115188$
with $p_t = 0.00850665$
 $p_c = 0.00862398$
 $p_v = 0.00287466$
 $N = 701.3709$
 $b = 300.00$
 $\rho = 0.11764706$
 $y_{\text{comp}} = 2.1691126\text{E-}005$
with $f_c = 33.00$
 $E_c = 26999.444$
 $y = 0.28410658$
 $A = 0.0199904$
 $B = 0.01112766$
with $E_s = 200000.00$

Calculation of ratio l_b/d

Lap Length: $l_d/d, \text{min} = 0.24294258$
 $l_b = 300.00$
 $l_d = 1234.86$
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d, min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
 $= 1$
 $db = 14.46154$
Mean strength value of all re-bars: $f_y = 555.56$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

- Calculation of ρ_p -

From table 10-7: $\rho_p = 0.02$

with:

- Condition iv occurred
Beam controlled by inadequate embedment into beam-column joint:
($l_b/d < 1$ and With Lapping in the Vicinity of the End Regions)
- Condition i occurred
Beam controlled by flexure: $V_p/V_o \leq 1$
shear control ratio $V_p/V_o = 0.39885187$
- Transverse Reinforcement: NC
- Stirrup Spacing $> d/3$
- Low ductility demand, $\rho_y < 2$ (table 10-6, ASCE 41-17)
 $= 6.9139455\text{E-}005$
- Stirrup Spacing $\leq d/2$
 $d = 357.00$
 $s = 150.00$
- Strength provided by hoops $V_s < 3/4$ *design Shear
 $V_s = 186169.943$, already given in calculation of shear control ratio
design Shear = 6236.526
- ($\rho - \rho_y$)/ $\rho_{bal} = -0.17558466$
 $= A_s l_t / (b w * d) = 0.00850665$

Tension Reinf Area: $A_{st} = 911.0619$

$\rho = A_{st}/(b_w \cdot d) = 0.01149864$

Compression Reinf Area: $A_{sc} = 1231.504$

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

$f_c = 33.00$

$f_y = 555.56$

From 10.2.7.3, ACI 318-11: $\beta_1 = 0.65$

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

- $V/(b_w \cdot d \cdot f_c^{0.5}) = 0.12207297$, NOTE: units in lb & in

$b_w = 300.00$

End Of Calculation of Chord Rotation Capacity for element: beam B1 of floor 1

At local axis: 2

Integration Section: (a)

Calculation No. 11

beam B1, Floor 1

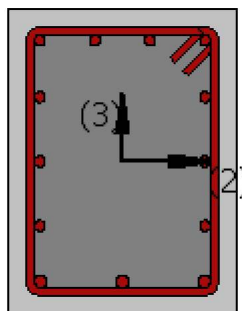
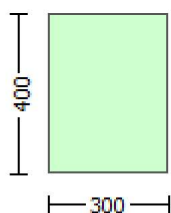
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: beam B1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

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

Consequently:

New material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 1850.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = l_b = 300.00$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 8.2483E+006$

Shear Force, $V_a = -6236.526$

EDGE -B-

Bending Moment, $M_b = 8.4157E+006$

Shear Force, $V_b = 11778.568$

BOTH EDGES

Axial Force, $F = -701.3709$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 911.0619$

-Compression: $A_{sc} = 1231.504$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{st,ten} = 911.0619$

-Compression: $A_{st,com} = 923.6282$

-Middle: $A_{st,mid} = 307.8761$

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

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 248098.976$

V_n ((22.5.1.1), ACI 318-14) = 248098.976

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

From Table (22.5.5.1), ACI 318-14: $V_c = 80547.368$

= 1 (normal-weight concrete)

$f'_c = 25.00$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$\rho_w = A_s / (b_w \cdot d) = 0.00949023$

A_s (tension reinf.) = 911.0619

$b_w = 300.00$

$d = 320.00$

$V_u \cdot d / M_u < 1 = 0.24195217$

$M_u = 8.2483E+006$

$V_u = 6236.526$

From (11.5.4.8), ACI 318-14: $V_s = 167551.608$

$A_v = 157079.633$

$f_y = 500.00$

$s = 150.00$

V_s 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: $V_s + V_f \leq 318865.838$

End Of Calculation of Shear Capacity for element: beam B1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 12

beam B1, Floor 1

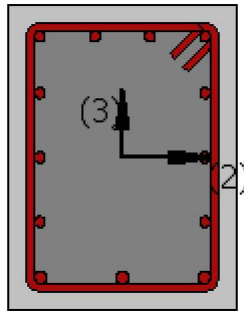
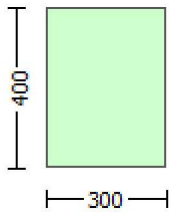
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (ϕ)

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

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

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

#####

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.06217

Element Length, $L = 1850.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_o = 300.00$
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, $V_a = 2771.022$
EDGE -B-
Shear Force, $V_b = 2771.021$
BOTH EDGES
Axial Force, $F = -190.7537$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_t = 911.0619$
-Compression: $As_c = 1231.504$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{t,ten} = 911.0619$
-Compression: $As_{l,com} = 923.6282$
-Middle: $As_{l,mid} = 307.8761$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.39885187$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 115624.954$
with
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 1.0444E+008$
 $Mu_{1+} = 1.0296E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
 $Mu_{1-} = 1.0444E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 1.0434E+008$
 $Mu_{2+} = 1.0305E+008$, 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
 $Mu_{2-} = 1.0434E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination
and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = 2771.022$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 2771.021$, is the shear force acting at edge 2 for the the static loading combination

Calculation of Mu_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 1.2093195E-005$
 $Mu = 1.0296E+008$

with full section properties:

$b = 300.00$
 $d = 357.00$
 $d' = 42.00$
 $v = 5.3972144E-005$
 $N = 190.7537$
 $f_c = 33.00$
 ϕ_o (5A.5, TBDY) = 0.002
Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_o) = 0.00721688$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\phi_u = 0.00721688$
 w_e (5.4c) = 0.00863449
 a_{se} ((5.4d), TBDY) = 0.15672608

bo = 240.00
ho = 340.00
bi2 = 346400.00
psh,min = Min(psh,x , psh,y) = 0.00261799

psh,x (5.4d) = 0.00349066
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 300.00

psh,y (5.4d) = 0.00261799
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00

s = 150.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00262167
c = confinement factor = 1.06217
y1 = 0.00104853
sh1 = 0.00335528
ft1 = 349.5114
fy1 = 291.2595
su1 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.19435406
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 = 291.2595
with Es1 = Es = 200000.00
y2 = 0.00104853
sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.19435406
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 = 291.2595
with Es2 = Es = 200000.00
yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.19435406
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.

```

with fsv = fs = 291.2595
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07508005
2 = Asl,com/(b*d)*(fs2/fc) = 0.07611563
v = Asl,mid/(b*d)*(fsv/fc) = 0.02537188
and confined core properties:
b = 240.00
d = 327.00
d' = 12.00
fcc (5A.2, TBDY) = 35.05152
cc (5A.5, TBDY) = 0.00262167
c = confinement factor = 1.06217
1 = Asl,ten/(b*d)*(fs1/fc) = 0.10246016
2 = Asl,com/(b*d)*(fs2/fc) = 0.1038734
v = Asl,mid/(b*d)*(fsv/fc) = 0.03462447
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.22282326
Mu = MRc (4.14) = 1.0296E+008
u = su (4.1) = 1.2093195E-005

```

Calculation of ratio lb/d

```

Lap Length: lb/d = 0.19435406
lb = 300.00
ld = 1543.575
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 14.46154
Mean strength value of all re-bars: fy = 694.45
t = 1.18462
s = 0.80
e = 1.00
cb = 25.00
Ktr = 3.22215
n = 13.00

```

Calculation of Mu1-

```

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.2082259E-005
Mu = 1.0444E+008

```

with full section properties:

```

b = 300.00
d = 358.00
d' = 43.00
v = 5.3821384E-005
N = 190.7537
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00721688
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00721688
we (5.4c) = 0.00863449
ase ((5.4d), TBDY) = 0.15672608
bo = 240.00
ho = 340.00

```

bi2 = 346400.00
psh,min = Min(psh,x , psh,y) = 0.00261799

psh,x (5.4d) = 0.00349066
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 300.00

psh,y (5.4d) = 0.00261799
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00

s = 150.00
fywe = 694.45
fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.00262167
c = confinement factor = 1.06217

y1 = 0.00104853
sh1 = 0.00335528
ft1 = 349.5114
fy1 = 291.2595
su1 = 0.00335528

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

lo/lou,min = lb/lb = 0.19435406

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 = 291.2595

with Es1 = Es = 200000.00

y2 = 0.00104853
sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528

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

lo/lou,min = lb/lb,min = 0.19435406

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 = 291.2595

with Es2 = Es = 200000.00

yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528

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

lo/lou,min = lb/lb = 0.19435406

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

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

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

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

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

with fsv = fs = 291.2595

with Esv = Es = 200000.00

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.07590302$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.07487033$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.02530101$$

and confined core properties:

$$b = 240.00$$

$$d = 328.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 35.05152$$

$$cc (5A.5, TBDY) = 0.00262167$$

$$c = \text{confinement factor} = 1.06217$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.10355671$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.10214778$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.0345189$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$su (4.9) = 0.22429266$$

$$\mu_u = M_{Rc} (4.14) = 1.0444E+008$$

$$u = su (4.1) = 1.2082259E-005$$

Calculation of ratio l_b/d

Lap Length: $l_b/d = 0.19435406$

$$l_b = 300.00$$

$$l_d = 1543.575$$

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

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

$$= 1$$

$$d_b = 14.46154$$

Mean strength value of all re-bars: $f_y = 694.45$

$$t = 1.18462$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 3.22215$$

$$n = 13.00$$

Calculation of μ_{u2+}

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

$$u = 1.2065709E-005$$

$$\mu_u = 1.0305E+008$$

with full section properties:

$$b = 300.00$$

$$d = 358.00$$

$$d' = 43.00$$

$$v = 5.3821384E-005$$

$$N = 190.7537$$

$$f_c = 33.00$$

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

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00721688$$

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

$$\text{From (5.4b), TBDY: } cu = 0.00721688$$

$$w_e (5.4c) = 0.00863449$$

$$ase ((5.4d), TBDY) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$bi2 = 346400.00$$

$$psh_{min} = \text{Min}(psh_x, psh_y) = 0.00261799$$

psh,x (5.4d) = 0.00349066
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 300.00

psh,y (5.4d) = 0.00261799
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00

s = 150.00
fywe = 694.45
fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00262167
c = confinement factor = 1.06217

y1 = 0.00104853
sh1 = 0.00335528

ft1 = 349.5114

fy1 = 291.2595

su1 = 0.00335528

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

lo/lou,min = lb/d = 0.19435406

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 = 291.2595

with Es1 = Es = 200000.00

y2 = 0.00104853

sh2 = 0.00335528

ft2 = 349.5114

fy2 = 291.2595

su2 = 0.00335528

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

lo/lou,min = lb/lb,min = 0.19435406

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 = 291.2595

with Es2 = Es = 200000.00

yv = 0.00104853

shv = 0.00335528

ftv = 349.5114

fyv = 291.2595

suv = 0.00335528

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

lo/lou,min = lb/d = 0.19435406

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 = 291.2595

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.07487033

2 = Asl,com/(b*d)*(fs2/fc) = 0.07590302

$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.02530101$
 and confined core properties:
 $b = 240.00$
 $d = 328.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.10214778$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.10355671$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.0345189$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.22322862$
 $Mu = MRc (4.14) = 1.0305E+008$
 $u = su (4.1) = 1.2065709E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$
 $l_b = 300.00$
 $l_d = 1543.575$
 Calculation of l_b,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 14.46154$
 Mean strength value of all re-bars: $f_y = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

Calculation of Mu_2 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.2109886E-005$
 $Mu = 1.0434E+008$

with full section properties:

$b = 300.00$
 $d = 357.00$
 $d' = 42.00$
 $v = 5.3972144E-005$
 $N = 190.7537$
 $f_c = 33.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00721688$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.00721688$
 $we (5.4c) = 0.00863449$
 $ase ((5.4d), TBDY) = 0.15672608$
 $bo = 240.00$
 $ho = 340.00$
 $bi2 = 346400.00$
 $psh,min = \text{Min}(psh,x, psh,y) = 0.00261799$
 $psh,x (5.4d) = 0.00349066$

Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 300.00

psh,y (5.4d) = 0.00261799
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00

s = 150.00
fywe = 694.45
fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00262167
c = confinement factor = 1.06217

y1 = 0.00104853
sh1 = 0.00335528
ft1 = 349.5114
fy1 = 291.2595
su1 = 0.00335528

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

lo/lou,min = lb/ld = 0.19435406

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

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

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

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

with fs1 = fs = 291.2595

with Es1 = Es = 200000.00

y2 = 0.00104853
sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528

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

lo/lou,min = lb/lb,min = 0.19435406

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 = 291.2595

with Es2 = Es = 200000.00

yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528

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

lo/lou,min = lb/ld = 0.19435406

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 = 291.2595

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.07611563

2 = Asl,com/(b*d)*(fs2/fc) = 0.07508005

v = Asl,mid/(b*d)*(fsv/fc) = 0.02537188

and confined core properties:

$b = 240.00$
 $d = 327.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = A_{s1,ten}/(b*d)*(f_{s1}/f_c) = 0.1038734$
 $2 = A_{s1,com}/(b*d)*(f_{s2}/f_c) = 0.10246016$
 $v = A_{s1,mid}/(b*d)*(f_{sv}/f_c) = 0.03462447$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.22389443$
 $Mu = MRc (4.14) = 1.0434E+008$
 $u = su (4.1) = 1.2109886E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$
 $l_b = 300.00$
 $l_d = 1543.575$
 Calculation of l_b, \min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d, \min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 14.46154$
 Mean strength value of all re-bars: $f_y = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 289894.477$

Calculation of Shear Strength at edge 1, $V_{r1} = 289894.477$
 $V_{r1} = V_n ((22.5.1.1), ACI 318-14)$

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

From Table (22.5.5.1), ACI 318-14: $V_c = 103724.534$
 $= 1$ (normal-weight concrete)
 $f_c' = 33.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $p_w = A_s/(b_w*d) = 0.00949023$
 A_s (tension reinf.) = 911.0619
 $b_w = 300.00$
 $d = 320.00$
 $V_u*d/Mu < 1 = 1.00$
 $Mu = 71454.459$
 $V_u = 2771.022$
 From (11.5.4.8), ACI 318-14: $V_s = 186169.943$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$
 V_s 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: $V_s + V_f \leq 366348.956$

Calculation of Shear Strength at edge 2, $V_{r2} = 289894.477$
 $V_{r2} = V_n ((22.5.1.1), ACI 318-14)$

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

From Table (22.5.5.1), ACI 318-14: $V_c = 103724.534$
= 1 (normal-weight concrete)
 $f'_c = 33.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s/(b_w*d) = 0.00949023$
 A_s (tension reinf.) = 911.0619
 $b_w = 300.00$
 $d = 320.00$
 $V_u*d/M_u < 1 = 1.00$
 $M_u = 71455.367$
 $V_u = 2771.021$
From (11.5.4.8), ACI 318-14: $V_s = 186169.943$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$
 V_s 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: $V_s + V_f \leq 366348.956$

End Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcars

Constant Properties

Knowledge Factor, $\phi = 1.00$
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$

Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, $f_s = 1.25*f_{sm} = 694.45$

Section Height, $H = 400.00$
Section Width, $W = 300.00$
Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.06217
Element Length, $L = 1850.00$
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_o = 300.00$
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = -2.7041243E-015$
EDGE -B-

Shear Force, $V_b = 2.7041243\text{E-}015$
 BOTH EDGES
 Axial Force, $F = -190.7537$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 911.0619$
 -Compression: $As_c = 1231.504$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 816.8141$
 -Compression: $As_{c,com} = 816.8141$
 -Middle: $As_{mid} = 508.938$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.38581165$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 74445.088$
 with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 6.8862\text{E+}007$
 $\mu_{u1+} = 6.8862\text{E+}007$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{u1-} = 6.8862\text{E+}007$, 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
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 6.8862\text{E+}007$
 $\mu_{u2+} = 6.8862\text{E+}007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{u2-} = 6.8862\text{E+}007$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
 and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
 with
 $V_1 = -2.7041243\text{E-}015$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 2.7041243\text{E-}015$, is the shear force acting at edge 2 for the static loading combination

Calculation of μ_{u1+}

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

$\phi_u = 1.7004869\text{E-}005$
 $\mu_u = 6.8862\text{E+}007$

with full section properties:

$b = 400.00$
 $d = 258.00$
 $d' = 42.00$
 $v = 5.6011789\text{E-}005$
 $N = 190.7537$
 $f_c = 33.00$
 $\phi_{co} (5A.5, \text{TBDY}) = 0.002$
 Final value of ϕ_{cu} : $\phi_{cu}^* = \text{shear_factor} \cdot \text{Max}(\phi_{cu}, \phi_{co}) = 0.00721688$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\phi_{cu} = 0.00721688$
 $\phi_{we} (5.4c) = 0.00863449$
 $\phi_{ase} ((5.4d), \text{TBDY}) = 0.15672608$
 $b_o = 240.00$
 $h_o = 340.00$
 $b_{i2} = 346400.00$
 $\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.00261799$

$\phi_{psh,x} (5.4d) = 0.00349066$
 $A_{sh} = A_{stir} \cdot n_s = 78.53982$
 No stirrups, $n_s = 2.00$
 $b_k = 300.00$

$\phi_{psh,y} (5.4d) = 0.00261799$

$$Ash = Astir * ns = 78.53982$$

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

$$bk = 400.00$$

$$s = 150.00$$

$$fywe = 694.45$$

$$fce = 33.00$$

$$\text{From } ((5.5), \text{TDY}), \text{TDY: } cc = 0.00262167$$

$$c = \text{confinement factor} = 1.06217$$

$$y1 = 0.00104853$$

$$sh1 = 0.00335528$$

$$ft1 = 349.5114$$

$$fy1 = 291.2595$$

$$su1 = 0.00335528$$

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

$$lo/lou, \min = lb/ld = 0.19435406$$

$$su1 = 0.4 * esu1_nominal ((5.5), \text{TDY}) = 0.032$$

From table 5A.1, TDY: 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, TDY.

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

$$\text{with } fs1 = fs = 291.2595$$

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

$$y2 = 0.00104853$$

$$sh2 = 0.00335528$$

$$ft2 = 349.5114$$

$$fy2 = 291.2595$$

$$su2 = 0.00335528$$

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

$$lo/lou, \min = lb/lb, \min = 0.19435406$$

$$su2 = 0.4 * esu2_nominal ((5.5), \text{TDY}) = 0.032$$

From table 5A.1, TDY: 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, TDY.

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

$$\text{with } fs2 = fs = 291.2595$$

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

$$yv = 0.00104853$$

$$shv = 0.00335528$$

$$ftv = 349.5114$$

$$fyv = 291.2595$$

$$suv = 0.00335528$$

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

$$lo/lou, \min = lb/ld = 0.19435406$$

$$suv = 0.4 * esuv_nominal ((5.5), \text{TDY}) = 0.032$$

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

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

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

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

$$\text{with } fsv = fs = 291.2595$$

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

$$1 = Asl, \text{ten} / (b * d) * (fs1 / fc) = 0.06985696$$

$$2 = Asl, \text{com} / (b * d) * (fs2 / fc) = 0.06985696$$

$$v = Asl, \text{mid} / (b * d) * (fsv / fc) = 0.04352626$$

and confined core properties:

$$b = 340.00$$

$$d = 228.00$$

$$d' = 12.00$$

$$fcc (5A.2, \text{TDY}) = 35.05152$$

$$cc (5A.5, \text{TDY}) = 0.00262167$$

c = confinement factor = 1.06217

1 = $Asl_{ten}/(b*d)*(fs1/fc) = 0.09299842$

2 = $Asl_{com}/(b*d)*(fs2/fc) = 0.09299842$

v = $Asl_{mid}/(b*d)*(fsv/fc) = 0.05794517$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.23522079

Mu = MRc (4.14) = 6.8862E+007

u = su (4.1) = 1.7004869E-005

Calculation of ratio lb/d

Lap Length: lb/d = 0.19435406

lb = 300.00

ld = 1543.575

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

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

= 1

db = 14.46154

Mean strength value of all re-bars: fy = 694.45

t = 1.18462

s = 0.80

e = 1.00

cb = 25.00

Ktr = 3.22215

n = 13.00

Calculation of Mu1-

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

u = 1.7004869E-005

Mu = 6.8862E+007

with full section properties:

b = 400.00

d = 258.00

d' = 42.00

v = 5.6011789E-005

N = 190.7537

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu: $cu^* = shear_factor * Max(cu, cc) = 0.00721688$

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

From (5.4b), TBDY: cu = 0.00721688

we (5.4c) = 0.00863449

ase ((5.4d), TBDY) = 0.15672608

bo = 240.00

ho = 340.00

bi2 = 346400.00

psh,min = Min(psh,x , psh,y) = 0.00261799

psh,x (5.4d) = 0.00349066

Ash = Astir*ns = 78.53982

No stirups, ns = 2.00

bk = 300.00

psh,y (5.4d) = 0.00261799

Ash = Astir*ns = 78.53982

No stirups, ns = 2.00

bk = 400.00

s = 150.00

fywe = 694.45

fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.00262167

c = confinement factor = 1.06217

y1 = 0.00104853

sh1 = 0.00335528

ft1 = 349.5114

fy1 = 291.2595

su1 = 0.00335528

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

lo/lou,min = lb/d = 0.19435406

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 = 291.2595

with Es1 = Es = 200000.00

y2 = 0.00104853

sh2 = 0.00335528

ft2 = 349.5114

fy2 = 291.2595

su2 = 0.00335528

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

lo/lou,min = lb/lb,min = 0.19435406

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 = 291.2595

with Es2 = Es = 200000.00

yv = 0.00104853

shv = 0.00335528

ftv = 349.5114

fyv = 291.2595

suv = 0.00335528

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

lo/lou,min = lb/d = 0.19435406

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 = 291.2595

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.06985696

2 = Asl,com/(b*d)*(fs2/fc) = 0.06985696

v = Asl,mid/(b*d)*(fsv/fc) = 0.04352626

and confined core properties:

b = 340.00

d = 228.00

d' = 12.00

fcc (5A.2, TBDY) = 35.05152

cc (5A.5, TBDY) = 0.00262167

c = confinement factor = 1.06217

1 = Asl,ten/(b*d)*(fs1/fc) = 0.09299842

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.09299842$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05794517$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$s_u(4.9) = 0.23522079$$

$$M_u = M_{Rc}(4.14) = 6.8862E+007$$

$$u = s_u(4.1) = 1.7004869E-005$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$$l_b = 300.00$$

$$l_d = 1543.575$$

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

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

$$= 1$$

$$d_b = 14.46154$$

Mean strength value of all re-bars: $f_y = 694.45$

$$t = 1.18462$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 3.22215$$

$$n = 13.00$$

Calculation of M_{u2+}

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

$$u = 1.7004869E-005$$

$$M_u = 6.8862E+007$$

with full section properties:

$$b = 400.00$$

$$d = 258.00$$

$$d' = 42.00$$

$$v = 5.6011789E-005$$

$$N = 190.7537$$

$$f_c = 33.00$$

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

$$\text{Final value of } \alpha: \alpha^* = \text{shear_factor} * \text{Max}(\alpha, \alpha_c) = 0.00721688$$

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

$$\text{From (5.4b), TBDY: } \alpha = 0.00721688$$

$$\alpha_w(5.4c) = 0.00863449$$

$$\alpha_{se}((5.4d), TBDY) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00261799$$

$$p_{sh,x}(5.4d) = 0.00349066$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

No stirrups, $n_s = 2.00$

$$b_k = 300.00$$

$$p_{sh,y}(5.4d) = 0.00261799$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

No stirrups, $n_s = 2.00$

$$b_k = 400.00$$

```

s = 150.00
fywe = 694.45
fce = 33.00
From ((5.A.5), TBDY), TBDY: cc = 0.00262167
c = confinement factor = 1.06217
y1 = 0.00104853
sh1 = 0.00335528
ft1 = 349.5114
fy1 = 291.2595
su1 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.19435406
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 291.2595
with Es1 = Es = 200000.00
y2 = 0.00104853
sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.19435406
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 291.2595
with Es2 = Es = 200000.00
yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.19435406
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 291.2595
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06985696
2 = Asl,com/(b*d)*(fs2/fc) = 0.06985696
v = Asl,mid/(b*d)*(fsv/fc) = 0.04352626
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 35.05152
cc (5A.5, TBDY) = 0.00262167
c = confinement factor = 1.06217
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09299842
2 = Asl,com/(b*d)*(fs2/fc) = 0.09299842
v = Asl,mid/(b*d)*(fsv/fc) = 0.05794517

```

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

--->

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

--->

μ_u (4.9) = 0.23522079

$M_u = M_{Rc}$ (4.14) = 6.8862E+007

$u = \mu_u$ (4.1) = 1.7004869E-005

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$l_b = 300.00$

$l_d = 1543.575$

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

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

= 1

$d_b = 14.46154$

Mean strength value of all re-bars: $f_y = 694.45$

$t = 1.18462$

$s = 0.80$

$e = 1.00$

$c_b = 25.00$

$K_{tr} = 3.22215$

$n = 13.00$

Calculation of μ_{u2} -

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

$u = 1.7004869E-005$

$M_u = 6.8862E+007$

with full section properties:

$b = 400.00$

$d = 258.00$

$d' = 42.00$

$v = 5.6011789E-005$

$N = 190.7537$

$f_c = 33.00$

ϕ (5A.5, TBDY) = 0.002

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.00721688$

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

From (5.4b), TBDY: $\mu_u = 0.00721688$

μ_{ue} (5.4c) = 0.00863449

μ_{ase} ((5.4d), TBDY) = 0.15672608

$b_o = 240.00$

$h_o = 340.00$

$b_{i2} = 346400.00$

$\mu_{sh,min} = \text{Min}(\mu_{sh,x}, \mu_{sh,y}) = 0.00261799$

$\mu_{sh,x}$ (5.4d) = 0.00349066

$A_{sh} = A_{stir} * n_s = 78.53982$

No stirrups, $n_s = 2.00$

$b_k = 300.00$

$\mu_{sh,y}$ (5.4d) = 0.00261799

$A_{sh} = A_{stir} * n_s = 78.53982$

No stirrups, $n_s = 2.00$

$b_k = 400.00$

$s = 150.00$

$f_{ywe} = 694.45$

```

fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00262167
c = confinement factor = 1.06217
y1 = 0.00104853
sh1 = 0.00335528
ft1 = 349.5114
fy1 = 291.2595
su1 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.19435406
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 291.2595
with Es1 = Es = 200000.00
y2 = 0.00104853
sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.19435406
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 291.2595
with Es2 = Es = 200000.00
yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.19435406
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 291.2595
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06985696
2 = Asl,com/(b*d)*(fs2/fc) = 0.06985696
v = Asl,mid/(b*d)*(fsv/fc) = 0.04352626
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 35.05152
cc (5A.5, TBDY) = 0.00262167
c = confinement factor = 1.06217
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09299842
2 = Asl,com/(b*d)*(fs2/fc) = 0.09299842
v = Asl,mid/(b*d)*(fsv/fc) = 0.05794517
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

```

--->

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

--->

$$s_u(4.9) = 0.23522079$$

$$M_u = M_{Rc}(4.14) = 6.8862E+007$$

$$u = s_u(4.1) = 1.7004869E-005$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$$l_b = 300.00$$

$$l_d = 1543.575$$

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

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

$$= 1$$

$$d_b = 14.46154$$

Mean strength value of all re-bars: $f_y = 694.45$

$$t = 1.18462$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 3.22215$$

$$n = 13.00$$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 192957.075$

Calculation of Shear Strength at edge 1, $V_{r1} = 192957.075$

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

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

From Table (22.5.5.1), ACI 318-14: $V_c = 88236.482$

$= 1$ (normal-weight concrete)

$$f'_c = 33.00, \text{ but } f_c^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$p_w = A_s/(b_w*d) = 0.00949023$$

$$A_s \text{ (tension reinf.)} = 911.0619$$

$$b_w = 400.00$$

$$d = 240.00$$

$$V_u*d/M_u < 1 = 0.00$$

$$M_u = 9.6361865E-012$$

$$V_u = 2.7041243E-015$$

From (11.5.4.8), ACI 318-14: $V_s = 104720.593$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

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

$$2(1-s/d) = 0.75$$

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

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 366348.956$$

Calculation of Shear Strength at edge 2, $V_{r2} = 192957.075$

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

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

From Table (22.5.5.1), ACI 318-14: $V_c = 88236.482$

$= 1$ (normal-weight concrete)

$$f'_c = 33.00, \text{ but } f_c^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$p_w = A_s/(b_w*d) = 0.00949023$$

$$A_s \text{ (tension reinf.)} = 911.0619$$

$$b_w = 400.00$$

$d = 240.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 4.6338743E-012$
 $V_u = 2.7041243E-015$
 From (11.5.4.8), ACI 318-14: $V_s = 104720.593$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$
 V_s has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17, 10.3.4)
 $2(1-s/d) = 0.75$
 $V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$
 From (11-11), ACI 440: $V_s + V_f \leq 366348.956$

 End Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1
 At local axis: 2

 Start Of Calculation of Chord Rotation Capacity for element: beam B1 of floor 1
 At local axis: 3
 Integration Section: (a)
 Section Type: rcars

Constant Properties

 Knowledge Factor, $= 1.00$
 Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
 Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
 Consequently:
 New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
 New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$
 Concrete Elasticity, $E_c = 26999.444$
 Steel Elasticity, $E_s = 200000.00$
 Section Height, $H = 400.00$
 Section Width, $W = 300.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 1850.00$
 Secondary Member
 Smooth Bars
 Ductile Steel
 With Detailing for Earthquake Resistance (including stirrups closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $l_b = 300.00$
 No FRP Wrapping

Stepwise Properties

 Bending Moment, $M = -7.4560473E-011$
 Shear Force, $V_2 = -7.2286192E-014$
 Shear Force, $V_3 = -6236.526$
 Axial Force, $F = -701.3709$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 911.0619$
 -Compression: $As_c = 1231.504$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{l,ten} = 816.8141$
 -Compression: $As_{l,com} = 816.8141$
 -Middle: $As_{l,mid} = 508.938$
 Mean Diameter of Tension Reinforcement, $Db_L = 14.40$

 New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.0225644$
 $u = y + p = 0.0225644$

- Calculation of y -

$y = (M_y \cdot L_s / 3) / E_{eff} = 0.0025644$ ((4.29), Biskinis Phd))
 $M_y = 6.0629E+007$
 $L_s = M/V$ (with $L_s > 0.1 \cdot L$ and $L_s < 2 \cdot L$) = 925.00
From table 10.5, ASCE 41_17: $E_{eff} = 0.3 \cdot E_c \cdot I_g = 7.2898E+012$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 7.4481424E-006$
with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 \cdot f_y \cdot (I_b / I_d)^{2/3}) = 270.3814$
 $d = 258.00$
 $y = 0.29647576$
 $A = 0.02078644$
 $B = 0.01209566$
with $p_t = 0.00791487$
 $p_c = 0.00791487$
 $p_v = 0.00493157$
 $N = 701.3709$
 $b = 400.00$
 $" = 0.1627907$
 $y_{comp} = 2.8783181E-005$
with $f_c = 33.00$
 $E_c = 26999.444$
 $y = 0.29626007$
 $A = 0.02074585$
 $B = 0.01207052$
with $E_s = 200000.00$

Calculation of ratio I_b / I_d

Lap Length: $I_d / I_{d,min} = 0.24294258$
 $I_b = 300.00$
 $I_d = 1234.86$
Calculation of I according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $I_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
 $= 1$
 $db = 14.46154$
Mean strength value of all re-bars: $f_y = 555.56$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

- Calculation of p -

From table 10-7: $p = 0.02$

with:

- Condition iv occurred
Beam controlled by inadequate embedment into beam-column joint:
($I_b / I_d < 1$ and With Lapping in the Vicinity of the End Regions)
- Condition i occurred
Beam controlled by flexure: $V_p / V_o \leq 1$
shear control ratio $V_p / V_o = 0.38581165$
- Transverse Reinforcement: NC

- Stirrup Spacing $> d/3$
- Low ductility demand, $\lambda / y < 2$ (table 10-6, ASCE 41-17)
 $= -1.3173849E-021$
- Stirrup Spacing $> d/2$
 $d = 258.00$
 $s = 150.00$
- Strength provided by hoops $V_s < 3/4 \cdot \text{design Shear}$
 $V_s = 139627.457$, already given in calculation of shear control ratio
 $\text{design Shear} = 7.2286192E-014$
- $(\lambda - \lambda') / \text{bal} = -0.18222013$
 $= A_{st}/(b_w \cdot d) = 0.00882812$
 Tension Reinf Area: $A_{st} = 911.0619$
 $\lambda' = A_{sc}/(b_w \cdot d) = 0.01193318$
 Compression Reinf Area: $A_{sc} = 1231.504$
 From (B-1), ACI 318-11: $\text{bal} = 0.01704017$
 $f_c = 33.00$
 $f_y = 555.56$
 From 10.2.7.3, ACI 318-11: $\lambda = 0.65$
 From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + \lambda) = 0.51922877$
 $\lambda = 0.0027778$
- $V/(b_w \cdot d \cdot f_c^{0.5}) = 1.4683917E-018$, NOTE: units in lb & in
 $b_w = 400.00$

End Of Calculation of Chord Rotation Capacity for element: beam B1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 13

beam B1, Floor 1

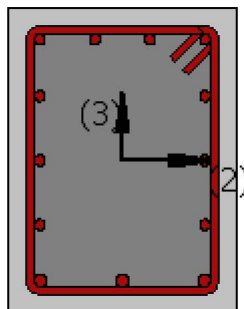
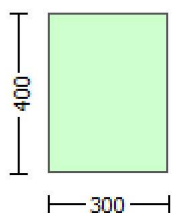
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: beam B1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcars

Constant Properties

Knowledge Factor, $\phi = 1.00$

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

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

Consequently:

New material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 1850.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = l_b = 300.00$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = -7.4560473E-011$

Shear Force, $V_a = -7.2286192E-014$

EDGE -B-

Bending Moment, $M_b = -5.9205937E-011$

Shear Force, $V_b = 7.2286192E-014$

BOTH EDGES

Axial Force, $F = -701.3709$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 923.6282$

-Compression: $As_c = 1218.938$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 816.8141$

-Compression: $As_{c,com} = 816.8141$

-Middle: $As_{mid} = 508.938$

Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 14.40$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $VR = 1.0 \cdot V_n = 171047.78$

V_n ((22.5.1.1), ACI 318-14) = 171047.78

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

From Table (22.5.5.1), ACI 318-14: $V_c = 76800.00$

= 1 (normal-weight concrete)

$f'_c = 25.00$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$\rho_w = As/(b_w \cdot d) = 0.00962113$

As (tension reinf.) = 923.6282

$b_w = 400.00$

$d = 240.00$

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

$M_u = 5.9205937E-011$

$$V_u = 7.2286192E-014$$

From (11.5.4.8), ACI 318-14: $V_s = 94247.78$

$$A_v = 157079.633$$

$$f_y = 500.00$$

$$s = 150.00$$

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

$$2(1-s/d) = 0.75$$

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

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 318865.838$$

End Of Calculation of Shear Capacity for element: beam B1 of floor 1

At local axis: 2

Integration Section: (b)

Calculation No. 14

beam B1, Floor 1

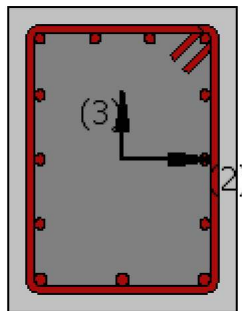
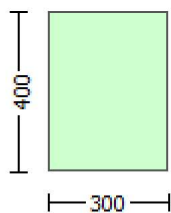
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (ϕ)

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcars

Constant Properties

Knowledge Factor, $\phi = 1.00$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

#####

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

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

#####

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.06217

Element Length, $L = 1850.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = 300.00$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 2771.022$

EDGE -B-

Shear Force, $V_b = 2771.021$

BOTH EDGES

Axial Force, $F = -190.7537$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 911.0619$

-Compression: $A_{sc} = 1231.504$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{st,ten} = 911.0619$

-Compression: $A_{st,com} = 923.6282$

-Middle: $A_{st,mid} = 307.8761$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.39885187$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 115624.954$
with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 1.0444E+008$

$M_{u1+} = 1.0296E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination

$M_{u1-} = 1.0444E+008$, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination

$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 1.0434E+008$

$M_{u2+} = 1.0305E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination

$M_{u2-} = 1.0434E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

and

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

with

$V_1 = 2771.022$, is the shear force acting at edge 1 for the the static loading combination

$V_2 = 2771.021$, is the shear force acting at edge 2 for the the static loading combination

Calculation of M_{u1+}

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

$\phi_u = 1.2093195E-005$

$M_u = 1.0296E+008$

with full section properties:

$$b = 300.00$$

$$d = 357.00$$

$$d' = 42.00$$

$$v = 5.3972144E-005$$

$$N = 190.7537$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi: \phi^* = \text{shear_factor} * \text{Max}(\phi, \phi_c) = 0.00721688$$

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

$$\text{From (5.4b), TB DY: } \phi = 0.00721688$$

$$\phi_w (5.4c) = 0.00863449$$

$$\phi_{se} ((5.4d), \text{TB DY}) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_i^2 = 346400.00$$

$$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00261799$$

$$\phi_{sh,x} (5.4d) = 0.00349066$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 300.00$$

$$\phi_{sh,y} (5.4d) = 0.00261799$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TB DY), TB DY: } \phi_c = 0.00262167$$

$$\phi_c = \text{confinement factor} = 1.06217$$

$$\phi_1 = 0.00104853$$

$$\phi_{sh1} = 0.00335528$$

$$f_{t1} = 349.5114$$

$$f_{y1} = 291.2595$$

$$\phi_{su1} = 0.00335528$$

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

$$\phi_o/\phi_{ou,min} = \phi_b/\phi_d = 0.19435406$$

$$\phi_{su1} = 0.4 * \phi_{su1_nominal} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } \phi_{su1_nominal} = 0.08,$$

For calculation of $\phi_{su1_nominal}$ and $\phi_1, \phi_{sh1}, f_{t1}, f_{y1}$, it is considered
characteristic value $\phi_{sy1} = \phi_{s1}/1.2$, from table 5.1, TB DY.

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

$$\text{with } \phi_{s1} = \phi_s = 291.2595$$

$$\text{with } E_{s1} = E_s = 200000.00$$

$$\phi_2 = 0.00104853$$

$$\phi_{sh2} = 0.00335528$$

$$f_{t2} = 349.5114$$

$$f_{y2} = 291.2595$$

$$\phi_{su2} = 0.00335528$$

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

$$\phi_o/\phi_{ou,min} = \phi_b/\phi_{b,min} = 0.19435406$$

$$\phi_{su2} = 0.4 * \phi_{su2_nominal} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } \phi_{su2_nominal} = 0.08,$$

For calculation of $\phi_{su2_nominal}$ and $\phi_2, \phi_{sh2}, f_{t2}, f_{y2}$, it is considered
characteristic value $\phi_{sy2} = \phi_{s2}/1.2$, from table 5.1, TB DY.

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

$$\text{with } \phi_{s2} = \phi_s = 291.2595$$

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

$$\phi_v = 0.00104853$$

$$\phi_{shv} = 0.00335528$$

```

ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/ld = 0.19435406
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = fs = 291.2595
    with Esv = Es = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.07508005
    2 = Asl,com/(b*d)*(fs2/fc) = 0.07611563
    v = Asl,mid/(b*d)*(fsv/fc) = 0.02537188
and confined core properties:
b = 240.00
d = 327.00
d' = 12.00
fcc (5A.2, TBDY) = 35.05152
cc (5A.5, TBDY) = 0.00262167
    c = confinement factor = 1.06217
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.10246016
    2 = Asl,com/(b*d)*(fs2/fc) = 0.1038734
    v = Asl,mid/(b*d)*(fsv/fc) = 0.03462447
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.22282326
Mu = MRc (4.14) = 1.0296E+008
u = su (4.1) = 1.2093195E-005
-----

Calculation of ratio lb/ld
-----

Lap Length: lb/ld = 0.19435406
lb = 300.00
ld = 1543.575
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 14.46154
Mean strength value of all re-bars: fy = 694.45
    t = 1.18462
    s = 0.80
    e = 1.00
    cb = 25.00
    Ktr = 3.22215
    n = 13.00
-----
-----
-----

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

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.2082259E-005
Mu = 1.0444E+008
-----

with full section properties:
b = 300.00

```

$d = 358.00$
 $d' = 43.00$
 $v = 5.3821384E-005$
 $N = 190.7537$
 $fc = 33.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = shear_factor * Max(cu, cc) = 0.00721688$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.00721688$
 $we (5.4c) = 0.00863449$
 $ase ((5.4d), TBDY) = 0.15672608$
 $bo = 240.00$
 $ho = 340.00$
 $bi2 = 346400.00$
 $psh,min = Min(psh,x, psh,y) = 0.00261799$

$psh,x (5.4d) = 0.00349066$
 $Ash = Astir*ns = 78.53982$
 No stirups, $ns = 2.00$
 $bk = 300.00$

$psh,y (5.4d) = 0.00261799$
 $Ash = Astir*ns = 78.53982$
 No stirups, $ns = 2.00$
 $bk = 400.00$

$s = 150.00$
 $fywe = 694.45$
 $fce = 33.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.00262167$
 $c = confinement\ factor = 1.06217$
 $y1 = 0.00104853$
 $sh1 = 0.00335528$
 $ft1 = 349.5114$
 $fy1 = 291.2595$
 $su1 = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/ld = 0.19435406$
 $su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu1_nominal = 0.08$,
 For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = fs = 291.2595$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00104853$
 $sh2 = 0.00335528$
 $ft2 = 349.5114$
 $fy2 = 291.2595$
 $su2 = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/lb,min = 0.19435406$
 $su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = fs = 291.2595$
 with $Es2 = Es = 200000.00$
 $yv = 0.00104853$
 $shv = 0.00335528$
 $ftv = 349.5114$
 $fyv = 291.2595$


```

suv = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lo,min = lb/ld = 0.19435406
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 291.2595
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07590302
2 = Asl,com/(b*d)*(fs2/fc) = 0.07487033
v = Asl,mid/(b*d)*(fsv/fc) = 0.02530101
and confined core properties:
b = 240.00
d = 328.00
d' = 13.00
fcc (5A.2, TBDY) = 35.05152
cc (5A.5, TBDY) = 0.00262167
c = confinement factor = 1.06217
1 = Asl,ten/(b*d)*(fs1/fc) = 0.10355671
2 = Asl,com/(b*d)*(fs2/fc) = 0.10214778
v = Asl,mid/(b*d)*(fsv/fc) = 0.0345189
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.22429266
Mu = MRc (4.14) = 1.0444E+008
u = su (4.1) = 1.2082259E-005
-----

Calculation of ratio lb/ld
-----
Lap Length: lb/ld = 0.19435406
lb = 300.00
ld = 1543.575
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 14.46154
Mean strength value of all re-bars: fy = 694.45
t = 1.18462
s = 0.80
e = 1.00
cb = 25.00
Ktr = 3.22215
n = 13.00
-----

Calculation of Mu2+
-----

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.2065709E-005
Mu = 1.0305E+008
-----
with full section properties:
b = 300.00
d = 358.00
d' = 43.00

```

```

v = 5.3821384E-005
N = 190.7537
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00721688
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00721688
we (5.4c) = 0.00863449
ase ((5.4d), TBDY) = 0.15672608
bo = 240.00
ho = 340.00
bi2 = 346400.00
psh,min = Min(psh,x , psh,y) = 0.00261799
-----
psh,x (5.4d) = 0.00349066
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 300.00
-----
psh,y (5.4d) = 0.00261799
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
-----
s = 150.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00262167
c = confinement factor = 1.06217
y1 = 0.00104853
sh1 = 0.00335528
ft1 = 349.5114
fy1 = 291.2595
su1 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.19435406
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 = 291.2595
with Es1 = Es = 200000.00
y2 = 0.00104853
sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.19435406
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 = 291.2595
with Es2 = Es = 200000.00
yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

```

and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.19435406$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v , sh_v , ft_v , fy_v , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 y_1 , sh_1 , ft_1 , fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 291.2595$
 with $Esv = Es = 200000.00$
 $1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.07487033$
 $2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.07590302$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.02530101$

and confined core properties:

$b = 240.00$
 $d = 328.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.10214778$
 $2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.10355671$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.0345189$

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

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.22322862$
 $Mu = MRc (4.14) = 1.0305E+008$
 $u = su (4.1) = 1.2065709E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$
 $l_b = 300.00$
 $l_d = 1543.575$
 Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 14.46154$
 Mean strength value of all re-bars: $fy = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

Calculation of Mu_2 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.2109886E-005$
 $Mu = 1.0434E+008$

with full section properties:

$b = 300.00$
 $d = 357.00$
 $d' = 42.00$
 $v = 5.3972144E-005$
 $N = 190.7537$

```

fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00721688
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00721688
we (5.4c) = 0.00863449
ase ((5.4d), TBDY) = 0.15672608
bo = 240.00
ho = 340.00
bi2 = 346400.00
psh,min = Min(psh,x , psh,y) = 0.00261799
-----
psh,x (5.4d) = 0.00349066
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 300.00
-----
psh,y (5.4d) = 0.00261799
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
-----
s = 150.00
fywe = 694.45
fce = 33.00
From ((5A5), TBDY), TBDY: cc = 0.00262167
c = confinement factor = 1.06217
y1 = 0.00104853
sh1 = 0.00335528
ft1 = 349.5114
fy1 = 291.2595
su1 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.19435406
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 = 291.2595
with Es1 = Es = 200000.00
y2 = 0.00104853
sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.19435406
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 = 291.2595
with Es2 = Es = 200000.00
yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

```

$l_o/l_{o,min} = l_b/d = 0.19435406$
 $s_{uv} = 0.4 * e_{suv_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $e_{suv_nominal} = 0.08$,
 considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $e_{suv_nominal}$ and y_v , sh_v , ft_v , f_{yv} , it is considered
 characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1 , sh_1 , ft_1 , f_{y1} , are also multiplied by $\text{Min}(1, 1.25 * (l_b/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = f_s = 291.2595$
 with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b*d) * (f_{s1}/f_c) = 0.07611563$
 $2 = A_{sl,com}/(b*d) * (f_{s2}/f_c) = 0.07508005$
 $v = A_{sl,mid}/(b*d) * (f_{sv}/f_c) = 0.02537188$

and confined core properties:

$b = 240.00$
 $d = 327.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = A_{sl,ten}/(b*d) * (f_{s1}/f_c) = 0.1038734$
 $2 = A_{sl,com}/(b*d) * (f_{s2}/f_c) = 0.10246016$
 $v = A_{sl,mid}/(b*d) * (f_{sv}/f_c) = 0.03462447$

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

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.22389443$
 $Mu = MRc (4.14) = 1.0434E+008$
 $u = su (4.1) = 1.2109886E-005$

Calculation of ratio l_b/d

Lap Length: $l_b/d = 0.19435406$
 $l_b = 300.00$
 $l_d = 1543.575$
 Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 14.46154$
 Mean strength value of all re-bars: $f_y = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 289894.477$

Calculation of Shear Strength at edge 1, $V_{r1} = 289894.477$
 $V_{r1} = V_n ((22.5.1.1), ACI 318-14)$

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

From Table (22.5.5.1), ACI 318-14: $V_c = 103724.534$
 $= 1$ (normal-weight concrete)
 $f'_c = 33.00$, but $f'_c^{0.5} \leq 8.3 \text{ MPa}$ (22.5.3.1, ACI 318-14)
 $p_w = A_s/(b_w*d) = 0.00949023$
 A_s (tension reinf.) = 911.0619
 $b_w = 300.00$
 $d = 320.00$

$$V_u \cdot d / M_u < 1 = 1.00$$

$$M_u = 71454.459$$

$$V_u = 2771.022$$

$$\text{From (11.5.4.8), ACI 318-14: } V_s = 186169.943$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

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

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

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 366348.956$$

Calculation of Shear Strength at edge 2, $V_{r2} = 289894.477$

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

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

$$\text{From Table (22.5.5.1), ACI 318-14: } V_c = 103724.534$$

= 1 (normal-weight concrete)

$$f'_c = 33.00, \text{ but } f'_c^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$p_w = A_s / (b_w \cdot d) = 0.00949023$$

$$A_s \text{ (tension reinf.)} = 911.0619$$

$$b_w = 300.00$$

$$d = 320.00$$

$$V_u \cdot d / M_u < 1 = 1.00$$

$$M_u = 71455.367$$

$$V_u = 2771.021$$

$$\text{From (11.5.4.8), ACI 318-14: } V_s = 186169.943$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

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

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

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 366348.956$$

End Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1

At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcars

Constant Properties

Knowledge Factor, = 1.00

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

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

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

#####

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.06217

Element Length, $L = 1850.00$

Secondary Member

Smooth Bars

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

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = -2.7041243E-015$
EDGE -B-
Shear Force, $V_b = 2.7041243E-015$
BOTH EDGES
Axial Force, $F = -190.7537$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl,t} = 911.0619$
-Compression: $A_{sl,c} = 1231.504$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten} = 816.8141$
-Compression: $A_{sl,com} = 816.8141$
-Middle: $A_{sl,mid} = 508.938$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.38581165$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 74445.088$
with
 $M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 6.8862E+007$
 $M_{u1+} = 6.8862E+007$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
 $M_{u1-} = 6.8862E+007$, 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
 $M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 6.8862E+007$
 $M_{u2+} = 6.8862E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
 $M_{u2-} = 6.8862E+007$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination
and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = -2.7041243E-015$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 2.7041243E-015$, is the shear force acting at edge 2 for the the static loading combination

Calculation of M_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 1.7004869E-005$
 $M_u = 6.8862E+007$

with full section properties:

$b = 400.00$
 $d = 258.00$
 $d' = 42.00$
 $v = 5.6011789E-005$
 $N = 190.7537$
 $f_c = 33.00$
 ϕ_o (5A.5, TBDY) = 0.002
Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_o) = 0.00721688$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\phi_u = 0.00721688$

$w_e(5.4c) = 0.00863449$
 $a_{se}((5.4d), TBDY) = 0.15672608$
 $b_o = 240.00$
 $h_o = 340.00$
 $b_{i2} = 346400.00$
 $p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00261799$

$p_{sh,x}(5.4d) = 0.00349066$
 $A_{sh} = A_{stir} \cdot n_s = 78.53982$
 No stirrups, $n_s = 2.00$
 $b_k = 300.00$

$p_{sh,y}(5.4d) = 0.00261799$
 $A_{sh} = A_{stir} \cdot n_s = 78.53982$
 No stirrups, $n_s = 2.00$
 $b_k = 400.00$

$s = 150.00$
 $f_{ywe} = 694.45$
 $f_{ce} = 33.00$
 From ((5.A5), TBDY), TBDY: $c_c = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $y_1 = 0.00104853$
 $sh_1 = 0.00335528$
 $ft_1 = 349.5114$
 $fy_1 = 291.2595$
 $su_1 = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $l_o/l_{ou,min} = l_b/l_d = 0.19435406$
 $su_1 = 0.4 \cdot esu_{1,nominal}((5.5), TBDY) = 0.032$
 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 $fsy_1 = f_s/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = f_s = 291.2595$
 with $Es_1 = E_s = 200000.00$
 $y_2 = 0.00104853$
 $sh_2 = 0.00335528$
 $ft_2 = 349.5114$
 $fy_2 = 291.2595$
 $su_2 = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.19435406$
 $su_2 = 0.4 \cdot esu_{2,nominal}((5.5), TBDY) = 0.032$
 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 $fsy_2 = f_s/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = f_s = 291.2595$
 with $Es_2 = E_s = 200000.00$
 $y_v = 0.00104853$
 $sh_v = 0.00335528$
 $ft_v = 349.5114$
 $fy_v = 291.2595$
 $suv = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $l_o/l_{ou,min} = l_b/l_d = 0.19435406$
 $suv = 0.4 \cdot esuv_{nominal}((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsy_v = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered

characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = f_s = 291.2595$
 with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.06985696$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.06985696$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.04352626$

and confined core properties:

$b = 340.00$
 $d = 228.00$
 $d' = 12.00$
 $f_{cc} \text{ (5A.2, TBDY)} = 35.05152$
 $cc \text{ (5A.5, TBDY)} = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.09299842$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.09299842$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.05794517$

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

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su \text{ (4.9)} = 0.23522079$
 $Mu = MR_c \text{ (4.14)} = 6.8862E+007$
 $u = su \text{ (4.1)} = 1.7004869E-005$

 Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$
 $l_b = 300.00$
 $l_d = 1543.575$
 Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 14.46154$
 Mean strength value of all re-bars: $f_y = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

 Calculation of Mu_1 -

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.7004869E-005$
 $Mu = 6.8862E+007$

with full section properties:

$b = 400.00$
 $d = 258.00$
 $d' = 42.00$
 $v = 5.6011789E-005$
 $N = 190.7537$
 $f_c = 33.00$
 $co \text{ (5A.5, TBDY)} = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.00721688$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.00721688$
 $we \text{ (5.4c)} = 0.00863449$
 $ase \text{ ((5.4d), TBDY)} = 0.15672608$

bo = 240.00
ho = 340.00
bi2 = 346400.00
psh,min = Min(psh,x , psh,y) = 0.00261799

psh,x (5.4d) = 0.00349066
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 300.00

psh,y (5.4d) = 0.00261799
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00

s = 150.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00262167
c = confinement factor = 1.06217
y1 = 0.00104853
sh1 = 0.00335528
ft1 = 349.5114
fy1 = 291.2595
su1 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.19435406
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 = 291.2595
with Es1 = Es = 200000.00
y2 = 0.00104853
sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.19435406
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 = 291.2595
with Es2 = Es = 200000.00
yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.19435406
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.

```

with fsv = fs = 291.2595
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06985696
2 = Asl,com/(b*d)*(fs2/fc) = 0.06985696
v = Asl,mid/(b*d)*(fsv/fc) = 0.04352626
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 35.05152
cc (5A.5, TBDY) = 0.00262167
c = confinement factor = 1.06217
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09299842
2 = Asl,com/(b*d)*(fs2/fc) = 0.09299842
v = Asl,mid/(b*d)*(fsv/fc) = 0.05794517
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.23522079
Mu = MRc (4.14) = 6.8862E+007
u = su (4.1) = 1.7004869E-005

```

Calculation of ratio lb/d

```

Lap Length: lb/d = 0.19435406
lb = 300.00
ld = 1543.575
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 14.46154
Mean strength value of all re-bars: fy = 694.45
t = 1.18462
s = 0.80
e = 1.00
cb = 25.00
Ktr = 3.22215
n = 13.00

```

Calculation of Mu2+

```

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.7004869E-005
Mu = 6.8862E+007

```

with full section properties:

```

b = 400.00
d = 258.00
d' = 42.00
v = 5.6011789E-005
N = 190.7537
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00721688
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00721688
we (5.4c) = 0.00863449
ase ((5.4d), TBDY) = 0.15672608
bo = 240.00
ho = 340.00

```

bi2 = 346400.00
psh,min = Min(psh,x , psh,y) = 0.00261799

psh,x (5.4d) = 0.00349066
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 300.00

psh,y (5.4d) = 0.00261799
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00

s = 150.00
fywe = 694.45
fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.00262167
c = confinement factor = 1.06217

y1 = 0.00104853
sh1 = 0.00335528
ft1 = 349.5114
fy1 = 291.2595
su1 = 0.00335528

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

lo/lou,min = lb/lb = 0.19435406

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 = 291.2595

with Es1 = Es = 200000.00

y2 = 0.00104853
sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528

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

lo/lou,min = lb/lb,min = 0.19435406

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 = 291.2595

with Es2 = Es = 200000.00

yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528

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

lo/lou,min = lb/lb = 0.19435406

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

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

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

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

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

with fsv = fs = 291.2595

with Esv = Es = 200000.00

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.06985696$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.06985696$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.04352626$$

and confined core properties:

$$b = 340.00$$

$$d = 228.00$$

$$d' = 12.00$$

$$f_{cc} (5A.2, TBDY) = 35.05152$$

$$cc (5A.5, TBDY) = 0.00262167$$

$$c = \text{confinement factor} = 1.06217$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.09299842$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.09299842$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05794517$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$s_u (4.9) = 0.23522079$$

$$\mu_u = M_{Rc} (4.14) = 6.8862E+007$$

$$u = s_u (4.1) = 1.7004869E-005$$

Calculation of ratio l_b/d

Lap Length: $l_b/d = 0.19435406$

$$l_b = 300.00$$

$$l_d = 1543.575$$

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

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

$$= 1$$

$$d_b = 14.46154$$

Mean strength value of all re-bars: $f_y = 694.45$

$$t = 1.18462$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 3.22215$$

$$n = 13.00$$

Calculation of μ_{u2} -

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

$$u = 1.7004869E-005$$

$$\mu_u = 6.8862E+007$$

with full section properties:

$$b = 400.00$$

$$d = 258.00$$

$$d' = 42.00$$

$$v = 5.6011789E-005$$

$$N = 190.7537$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu_u: \mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, cc) = 0.00721688$$

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

$$\text{From (5.4b), TBDY: } \mu_u = 0.00721688$$

$$w_e (5.4c) = 0.00863449$$

$$a_{se} ((5.4d), TBDY) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00261799$$

psh,x (5.4d) = 0.00349066
 Ash = Astir*ns = 78.53982
 No stirups, ns = 2.00
 bk = 300.00

psh,y (5.4d) = 0.00261799
 Ash = Astir*ns = 78.53982
 No stirups, ns = 2.00
 bk = 400.00

s = 150.00
 fywe = 694.45
 fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00262167
 c = confinement factor = 1.06217

y1 = 0.00104853
 sh1 = 0.00335528

ft1 = 349.5114

fy1 = 291.2595

su1 = 0.00335528

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

lo/lou,min = lb/ld = 0.19435406

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

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

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

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

with fs1 = fs = 291.2595

with Es1 = Es = 200000.00

y2 = 0.00104853

sh2 = 0.00335528

ft2 = 349.5114

fy2 = 291.2595

su2 = 0.00335528

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

lo/lou,min = lb/lb,min = 0.19435406

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 = 291.2595

with Es2 = Es = 200000.00

yv = 0.00104853

shv = 0.00335528

ftv = 349.5114

fyv = 291.2595

suv = 0.00335528

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

lo/lou,min = lb/ld = 0.19435406

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 = 291.2595

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.06985696

2 = Asl,com/(b*d)*(fs2/fc) = 0.06985696

$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.04352626$
 and confined core properties:
 $b = 340.00$
 $d = 228.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.09299842$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.09299842$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05794517$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.23522079$
 $Mu = MRc (4.14) = 6.8862E+007$
 $u = su (4.1) = 1.7004869E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$
 $l_b = 300.00$
 $l_d = 1543.575$
 Calculation of l_b,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 14.46154$
 Mean strength value of all re-bars: $f_y = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 192957.075$

Calculation of Shear Strength at edge 1, $V_{r1} = 192957.075$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14: $V_c = 88236.482$
 $= 1$ (normal-weight concrete)
 $f_c' = 33.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $pw = A_s/(b_w*d) = 0.00949023$
 A_s (tension reinf.) = 911.0619
 $b_w = 400.00$
 $d = 240.00$
 $V_u*d/Mu < 1 = 0.00$
 $Mu = 9.6361865E-012$
 $V_u = 2.7041243E-015$
 From (11.5.4.8), ACI 318-14: $V_s = 104720.593$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$
 V_s has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.75$
 V_f ((11-3)-(11.4), ACI 440) = 0.00
 From (11-11), ACI 440: $V_s + V_f \leq 366348.956$

Calculation of Shear Strength at edge 2, $V_{r2} = 192957.075$
 $V_{r2} = V_n ((22.5.1.1), \text{ACI } 318-14)$

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

From Table (22.5.5.1), ACI 318-14: $V_c = 88236.482$
= 1 (normal-weight concrete)
 $f_c' = 33.00$, but $f_c'^{0.5} \leq 8.3 \text{ MPa}$ (22.5.3.1, ACI 318-14)
 $\rho_w = A_s/(b_w \cdot d) = 0.00949023$
 A_s (tension reinf.) = 911.0619
 $b_w = 400.00$
 $d = 240.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 4.6338743\text{E-}012$
 $V_u = 2.7041243\text{E-}015$

From (11.5.4.8), ACI 318-14: $V_s = 104720.593$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$

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

$2(1-s/d) = 0.75$

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

From (11-11), ACI 440: $V_s + V_f \leq 366348.956$

End Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam B1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcars

Constant Properties

Knowledge Factor, $\phi = 1.00$

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

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 1850.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_b = 300.00$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 8.4157\text{E+}006$

Shear Force, $V_2 = 7.2286192\text{E-}014$

Shear Force, $V_3 = 11778.568$

Axial Force, $F = -701.3709$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 923.6282$
 -Compression: $As_c = 1218.938$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{ten} = 923.6282$
 -Compression: $As_{com} = 911.0619$
 -Middle: $As_{mid} = 307.8761$
 Mean Diameter of Tension Reinforcement, $Db_L = 14.00$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.02162617$
 $u = y + p = 0.02162617$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00162617$ ((4.29), Biskinis Phd))
 $M_y = 8.8489E+007$
 $L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 714.4901
 From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 1.2960E+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 5.2907804E-006$
 with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b / d)^{2/3}) = 270.3814$
 $d = 358.00$
 $y = 0.28625352$
 $A = 0.01997356$
 $B = 0.01124841$
 with $p_t = 0.00859989$
 $p_c = 0.00848289$
 $p_v = 0.00286663$
 $N = 701.3709$
 $b = 300.00$
 $" = 0.12011173$
 $y_{comp} = 2.1484954E-005$
 with $f_c = 33.00$
 $E_c = 26999.444$
 $y = 0.2860317$
 $A = 0.01993456$
 $B = 0.01122426$
 with $E_s = 200000.00$

Calculation of ratio l_b / d

Lap Length: $l_d / d_{min} = 0.24294258$
 $l_b = 300.00$
 $l_d = 1234.86$
 Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
 $= 1$
 $db = 14.46154$
 Mean strength value of all re-bars: $f_y = 555.56$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

- Calculation of p -

From table 10-7: $p = 0.02$

with:

- Condition iv occurred

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

- Condition i occurred

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

shear control ratio $V_p/V_o = 0.39885187$

- Transverse Reinforcement: NC

- Stirrup Spacing $> d/3$

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

$$= 3.7293501E-005$$

- Stirrup Spacing $\leq d/2$

$$d = 358.00$$

$$s = 150.00$$

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

$$V_s = 186169.943, \text{ already given in calculation of shear control ratio}$$

$$\text{design Shear} = 11778.568$$

$$- (- ') / \text{bal} = -0.16136132$$

$$= A_{st}/(b_w \cdot d) = 0.00859989$$

$$\text{Tension Reinf Area: } A_{st} = 923.6282$$

$$' = A_{sc}/(b_w \cdot d) = 0.01134952$$

$$\text{Compression Reinf Area: } A_{sc} = 1218.938$$

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

$$f_c = 33.00$$

$$f_y = 555.56$$

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

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

$$y = 0.0027778$$

$$- V/(b_w \cdot d \cdot f_c^{0.5}) = 0.22990821, \text{ NOTE: units in lb \& in}$$

$$b_w = 300.00$$

End Of Calculation of Chord Rotation Capacity for element: beam B1 of floor 1

At local axis: 2

Integration Section: (b)

Calculation No. 15

beam B1, Floor 1

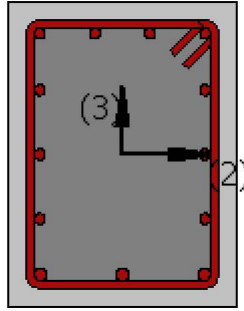
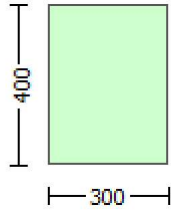
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: beam B1 of floor 1

At local axis: 3

Integration Section: (b)

Section Type: rcars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

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

Consequently:

New material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 1850.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = l_b = 300.00$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 8.2483E+006$

Shear Force, $V_a = -6236.526$

EDGE -B-

Bending Moment, $M_b = 8.4157E+006$

Shear Force, $V_b = 11778.568$

BOTH EDGES

Axial Force, $F = -701.3709$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_{lt} = 923.6282$

-Compression: $As_{lc} = 1218.938$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{l,ten} = 923.6282$

-Compression: $As_{l,com} = 911.0619$

-Middle: $As_{l,mid} = 307.8761$

Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 14.00$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $VR = 1.0 \cdot V_n = 251383.949$

V_n ((22.5.1.1), ACI 318-14) = 251383.949

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

From Table (22.5.5.1), ACI 318-14: $V_c = 83832.34$

= 1 (normal-weight concrete)

$f'_c = 25.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$\rho_w = A_s / (b_w * d) = 0.00962113$

A_s (tension reinf.) = 923.6282

$b_w = 300.00$

$d = 320.00$

$V_u * d / M_u < 1 = 0.44787184$

$M_u = 8.4157E+006$

$V_u = 11778.568$

From (11.5.4.8), ACI 318-14: $V_s = 167551.608$

$A_v = 157079.633$

$f_y = 500.00$

$s = 150.00$

V_s 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: $V_s + V_f \leq 318865.838$

End Of Calculation of Shear Capacity for element: beam B1 of floor 1

At local axis: 3

Integration Section: (b)

Calculation No. 16

beam B1, Floor 1

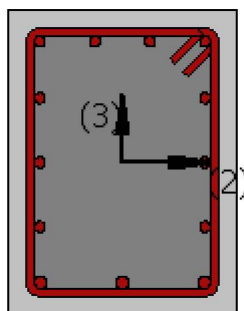
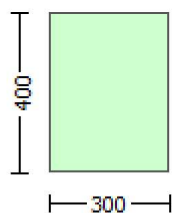
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (ϕ_r)

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

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

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

#####

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.06217

Element Length, $L = 1850.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = 300.00$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 2771.022$

EDGE -B-

Shear Force, $V_b = 2771.021$

BOTH EDGES

Axial Force, $F = -190.7537$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{sl,t} = 911.0619$

-Compression: $A_{sl,c} = 1231.504$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten} = 911.0619$

-Compression: $A_{sl,com} = 923.6282$

-Middle: $A_{sl,mid} = 307.8761$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.39885187$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 115624.954$
with

$M_{pr1} = \max(\mu_{1+}, \mu_{1-}) = 1.0444E+008$

$\mu_{1+} = 1.0296E+008$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$\mu_{1-} = 1.0444E+008$, 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

$M_{pr2} = \max(\mu_{2+}, \mu_{2-}) = 1.0434E+008$

$\mu_{2+} = 1.0305E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination

$\mu_{2-} = 1.0434E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination

and

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

with

V1 = 2771.022, is the shear force acting at edge 1 for the the static loading combination
V2 = 2771.021, is the shear force acting at edge 2 for the the static loading combination

Calculation of Mu1+

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

$$\phi_u = 1.2093195E-005$$

$$M_u = 1.0296E+008$$

with full section properties:

$$b = 300.00$$

$$d = 357.00$$

$$d' = 42.00$$

$$v = 5.3972144E-005$$

$$N = 190.7537$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.00721688$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.00721688$$

$$\phi_{ue} \text{ (5.4c)} = 0.00863449$$

$$\phi_{ase} \text{ ((5.4d), TBDY)} = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_i^2 = 346400.00$$

$$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00261799$$

$$\phi_{sh,x} \text{ (5.4d)} = 0.00349066$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 300.00$$

$$\phi_{sh,y} \text{ (5.4d)} = 0.00261799$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.00262167$$

$$c = \text{confinement factor} = 1.06217$$

$$y_1 = 0.00104853$$

$$sh_1 = 0.00335528$$

$$f_{t1} = 349.5114$$

$$f_{y1} = 291.2595$$

$$su_1 = 0.00335528$$

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

$$l_o/l_{ou,min} = l_b/l_d = 0.19435406$$

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

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

For calculation of $esu_1_{nominal}$ and $y_1, sh_1, f_{t1}, f_{y1}$, it is considered
characteristic value $fsy_1 = fs_1/1.2$, 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.

$$\text{with } fs_1 = fs = 291.2595$$

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

$$y_2 = 0.00104853$$

$$sh_2 = 0.00335528$$

$$f_{t2} = 349.5114$$

$$f_{y2} = 291.2595$$

$$su_2 = 0.00335528$$

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

and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_{b,min} = 0.19435406$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 291.2595$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00104853$
 $sh_v = 0.00335528$
 $ft_v = 349.5114$
 $fy_v = 291.2595$
 $suv = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 0.19435406$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 291.2595$
 with $Es_v = Es = 200000.00$
 $1 = A_{sl,ten}/(b*d) * (fs_1/f_c) = 0.07508005$
 $2 = A_{sl,com}/(b*d) * (fs_2/f_c) = 0.07611563$
 $v = A_{sl,mid}/(b*d) * (fsv/f_c) = 0.02537188$

and confined core properties:

$b = 240.00$
 $d = 327.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = A_{sl,ten}/(b*d) * (fs_1/f_c) = 0.10246016$
 $2 = A_{sl,com}/(b*d) * (fs_2/f_c) = 0.1038734$
 $v = A_{sl,mid}/(b*d) * (fsv/f_c) = 0.03462447$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su (4.9) = 0.22282326$

$Mu = MR_c (4.14) = 1.0296E+008$

$u = su (4.1) = 1.2093195E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$l_b = 300.00$

$l_d = 1543.575$

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

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

= 1

$db = 14.46154$

Mean strength value of all re-bars: $fy = 694.45$

$t = 1.18462$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 3.22215$

$n = 13.00$

Calculation of Mu1-

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

$$\mu = 1.2082259E-005$$

$$Mu = 1.0444E+008$$

with full section properties:

$$b = 300.00$$

$$d = 358.00$$

$$d' = 43.00$$

$$v = 5.3821384E-005$$

$$N = 190.7537$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu, c_o) = 0.00721688$$

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

$$\text{From (5.4b), TBDY: } \mu = 0.00721688$$

$$w_e(5.4c) = 0.00863449$$

$$a_{se}((5.4d), TBDY) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00261799$$

$$p_{sh,x}(5.4d) = 0.00349066$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 300.00$$

$$p_{sh,y}(5.4d) = 0.00261799$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.00262167$$

$$c = \text{confinement factor} = 1.06217$$

$$y_1 = 0.00104853$$

$$sh_1 = 0.00335528$$

$$f_{t1} = 349.5114$$

$$f_{y1} = 291.2595$$

$$su_1 = 0.00335528$$

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

$$l_o/l_{ou,min} = l_b/l_d = 0.19435406$$

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

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

For calculation of $esu_{1,nominal}$ and $y_1, sh_1, f_{t1}, f_{y1}$, it is considered
characteristic value $fsy_1 = f_s/1.2$, 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.

$$\text{with } fs_1 = f_s = 291.2595$$

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

$$y_2 = 0.00104853$$

$$sh_2 = 0.00335528$$

$$f_{t2} = 349.5114$$

$$f_{y2} = 291.2595$$

$$su_2 = 0.00335528$$

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

$l_o/l_{o,min} = l_b/l_{b,min} = 0.19435406$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 291.2595$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00104853$
 $sh_v = 0.00335528$
 $ft_v = 349.5114$
 $fy_v = 291.2595$
 $suv = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 0.19435406$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = fs = 291.2595$
 with $Es_v = Es = 200000.00$
 $1 = Asl_{ten}/(b*d)*(fs_1/f_c) = 0.07590302$
 $2 = Asl_{com}/(b*d)*(fs_2/f_c) = 0.07487033$
 $v = Asl_{mid}/(b*d)*(fs_v/f_c) = 0.02530101$

and confined core properties:

$b = 240.00$
 $d = 328.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = Asl_{ten}/(b*d)*(fs_1/f_c) = 0.10355671$
 $2 = Asl_{com}/(b*d)*(fs_2/f_c) = 0.10214778$
 $v = Asl_{mid}/(b*d)*(fs_v/f_c) = 0.0345189$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

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

---->

$su (4.9) = 0.22429266$

$\mu_u = MR_c (4.14) = 1.0444E+008$

$u = su (4.1) = 1.2082259E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$l_b = 300.00$

$l_d = 1543.575$

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

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

= 1

$db = 14.46154$

Mean strength value of all re-bars: $fy = 694.45$

$t = 1.18462$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 3.22215$

$n = 13.00$

Calculation of μ_{2+}

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

$$\mu = 1.2065709E-005$$

$$\mu = 1.0305E+008$$

with full section properties:

$$b = 300.00$$

$$d = 358.00$$

$$d' = 43.00$$

$$v = 5.3821384E-005$$

$$N = 190.7537$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu, c_o) = 0.00721688$$

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

$$\text{From (5.4b), TBDY: } \mu = 0.00721688$$

$$w_e(5.4c) = 0.00863449$$

$$a_s((5.4d), \text{TBDY}) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_i^2 = 346400.00$$

$$\mu_{sh,min} = \text{Min}(\mu_{sh,x}, \mu_{sh,y}) = 0.00261799$$

$$\mu_{sh,x}(5.4d) = 0.00349066$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 300.00$$

$$\mu_{sh,y}(5.4d) = 0.00261799$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.00262167$$

$$c = \text{confinement factor} = 1.06217$$

$$y_1 = 0.00104853$$

$$sh_1 = 0.00335528$$

$$f_{t1} = 349.5114$$

$$f_{y1} = 291.2595$$

$$su_1 = 0.00335528$$

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

$$\text{Shear_factor} = 1.00$$

$$l_o/l_{o,min} = l_b/l_d = 0.19435406$$

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

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

For calculation of $esu_{1,nominal}$ and $y_1, sh_1, f_{t1}, f_{y1}$, it is considered
characteristic value $f_{sy1} = f_{s1}/1.2$, from table 5.1, TBDY.

$$y_1, sh_1, f_{t1}, f_{y1}, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b/l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } f_{s1} = f_s = 291.2595$$

$$\text{with } E_{s1} = E_s = 200000.00$$

$$y_2 = 0.00104853$$

$$sh_2 = 0.00335528$$

$$f_{t2} = 349.5114$$

$$f_{y2} = 291.2595$$

$$su_2 = 0.00335528$$

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

$$\text{Shear_factor} = 1.00$$

$$l_o/l_{o,min} = l_b/l_{b,min} = 0.19435406$$

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

From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 For calculation of $esuv_{nominal}$ 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 $fs_2 = fs = 291.2595$
 with $Es_2 = Es = 200000.00$
 $yv = 0.00104853$
 $shv = 0.00335528$
 $ftv = 349.5114$
 $fyv = 291.2595$
 $suv = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou, min = lb/d = 0.19435406$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and yv , shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 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 $fsv = fs = 291.2595$
 with $Es_v = Es = 200000.00$
 $1 = Asl, ten / (b \cdot d) \cdot (fs_1 / fc) = 0.07487033$
 $2 = Asl, com / (b \cdot d) \cdot (fs_2 / fc) = 0.07590302$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.02530101$

and confined core properties:

$b = 240.00$
 $d = 328.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = Asl, ten / (b \cdot d) \cdot (fs_1 / fc) = 0.10214778$
 $2 = Asl, com / (b \cdot d) \cdot (fs_2 / fc) = 0.10355671$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.0345189$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su (4.9) = 0.22322862$
 $Mu = MRc (4.14) = 1.0305E+008$
 $u = su (4.1) = 1.2065709E-005$

Calculation of ratio lb/d

Lap Length: $lb/d = 0.19435406$
 $lb = 300.00$
 $ld = 1543.575$

Calculation of lb, min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 ld, min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$= 1$
 $db = 14.46154$
 Mean strength value of all re-bars: $fy = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 3.22215$
 $n = 13.00$

Calculation of Mu_2 -

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

$$\phi_u = 1.2109886E-005$$

$$\mu = 1.0434E+008$$

with full section properties:

$$b = 300.00$$

$$d = 357.00$$

$$d' = 42.00$$

$$\nu = 5.3972144E-005$$

$$N = 190.7537$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00721688$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00721688$$

$$\phi_{we} (5.4c) = 0.00863449$$

$$\phi_{ase} ((5.4d), TBDY) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_i^2 = 346400.00$$

$$\phi_{psh,min} = \text{Min}(\phi_{psh,x}, \phi_{psh,y}) = 0.00261799$$

$$\phi_{psh,x} (5.4d) = 0.00349066$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 300.00$$

$$\phi_{psh,y} (5.4d) = 0.00261799$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_{cc} = 0.00262167$$

$$c = \text{confinement factor} = 1.06217$$

$$y_1 = 0.00104853$$

$$sh_1 = 0.00335528$$

$$f_{t1} = 349.5114$$

$$f_{y1} = 291.2595$$

$$su_1 = 0.00335528$$

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

$$l_o/l_{ou,min} = l_b/l_d = 0.19435406$$

$$su_1 = 0.4 * esu1_{nominal} ((5.5), TBDY) = 0.032$$

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

For calculation of $esu1_{nominal}$ and $y_1, sh_1, f_{t1}, f_{y1}$, it is considered
characteristic value $f_{sy1} = f_{s1}/1.2$, 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.

$$\text{with } f_{s1} = f_s = 291.2595$$

$$\text{with } E_{s1} = E_s = 200000.00$$

$$y_2 = 0.00104853$$

$$sh_2 = 0.00335528$$

$$f_{t2} = 349.5114$$

$$f_{y2} = 291.2595$$

$$su_2 = 0.00335528$$

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

$$l_o/l_{ou,min} = l_b/l_{b,min} = 0.19435406$$

$$su_2 = 0.4 * esu2_{nominal} ((5.5), TBDY) = 0.032$$

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

For calculation of $esu2_{nominal}$ and $y_2, sh_2, f_{t2}, f_{y2}$, it is considered

characteristic value $f_{sy2} = f_{s2}/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{s2} = f_s = 291.2595$
 with $E_{s2} = E_s = 200000.00$
 $y_v = 0.00104853$
 $sh_v = 0.00335528$
 $ft_v = 349.5114$
 $fy_v = 291.2595$
 $suv = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 0.19435406$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = f_s = 291.2595$
 with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.07611563$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.07508005$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.02537188$

and confined core properties:

$b = 240.00$
 $d = 327.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.1038734$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.10246016$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.03462447$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su (4.9) = 0.22389443$
 $Mu = MR_c (4.14) = 1.0434E+008$
 $u = su (4.1) = 1.2109886E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$

$l_b = 300.00$

$l_d = 1543.575$

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

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

= 1

$db = 14.46154$

Mean strength value of all re-bars: $fy = 694.45$

$t = 1.18462$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 3.22215$

$n = 13.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 289894.477$

Calculation of Shear Strength at edge 1, $V_{r1} = 289894.477$

$Vr1 = Vn$ ((22.5.1.1), ACI 318-14)

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 (22.5.5.1), ACI 318-14: $Vc = 103724.534$

= 1 (normal-weight concrete)

$fc' = 33.00$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$pw = As/(bw \cdot d) = 0.00949023$

As (tension reinf.) = 911.0619

$bw = 300.00$

$d = 320.00$

$Vu \cdot d / Mu < 1 = 1.00$

$Mu = 71454.459$

$Vu = 2771.022$

From (11.5.4.8), ACI 318-14: $Vs = 186169.943$

$Av = 157079.633$

$fy = 555.56$

$s = 150.00$

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

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

From (11-11), ACI 440: $Vs + Vf \leq 366348.956$

Calculation of Shear Strength at edge 2, $Vr2 = 289894.477$

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

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 (22.5.5.1), ACI 318-14: $Vc = 103724.534$

= 1 (normal-weight concrete)

$fc' = 33.00$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$pw = As/(bw \cdot d) = 0.00949023$

As (tension reinf.) = 911.0619

$bw = 300.00$

$d = 320.00$

$Vu \cdot d / Mu < 1 = 1.00$

$Mu = 71455.367$

$Vu = 2771.021$

From (11.5.4.8), ACI 318-14: $Vs = 186169.943$

$Av = 157079.633$

$fy = 555.56$

$s = 150.00$

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

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

From (11-11), ACI 440: $Vs + Vf \leq 366348.956$

End Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1

At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcars

Constant Properties

Knowledge Factor, $= 1.00$

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

Consequently:

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

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

Concrete Elasticity, $Ec = 26999.444$

Steel Elasticity, $Es = 200000.00$

#####

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

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

#####

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.06217

Element Length, $L = 1850.00$

Secondary Member

Smooth Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = 300.00$

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = -2.7041243E-015$

EDGE -B-

Shear Force, $V_b = 2.7041243E-015$

BOTH EDGES

Axial Force, $F = -190.7537$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 911.0619$

-Compression: $As_c = 1231.504$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 816.8141$

-Compression: $As_{l,com} = 816.8141$

-Middle: $As_{l,mid} = 508.938$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.38581165$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 74445.088$
with

$M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 6.8862E+007$

$\mu_{u1+} = 6.8862E+007$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination

$\mu_{u1-} = 6.8862E+007$, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination

$M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 6.8862E+007$

$\mu_{u2+} = 6.8862E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the static loading combination

$\mu_{u2-} = 6.8862E+007$, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the static loading combination

and

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

with

$V_1 = -2.7041243E-015$, is the shear force acting at edge 1 for the static loading combination

$V_2 = 2.7041243E-015$, is the shear force acting at edge 2 for the static loading combination

Calculation of μ_{u1+}

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

$\phi_u = 1.7004869E-005$

$\mu_u = 6.8862E+007$

with full section properties:

$$b = 400.00$$

$$d = 258.00$$

$$d' = 42.00$$

$$v = 5.6011789E-005$$

$$N = 190.7537$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00721688$$

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

$$\text{From (5.4b), TB DY: } c_u = 0.00721688$$

$$w_e(5.4c) = 0.00863449$$

$$a_s((5.4d), \text{TB DY}) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00261799$$

$$p_{sh,x}(5.4d) = 0.00349066$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 300.00$$

$$p_{sh,y}(5.4d) = 0.00261799$$

$$A_{sh} = A_{stir} * n_s = 78.53982$$

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TB DY), TB DY: } c_c = 0.00262167$$

$$c = \text{confinement factor} = 1.06217$$

$$y_1 = 0.00104853$$

$$sh_1 = 0.00335528$$

$$f_{t1} = 349.5114$$

$$f_{y1} = 291.2595$$

$$su_1 = 0.00335528$$

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

$$l_o/l_{o,min} = l_b/l_d = 0.19435406$$

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

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

For calculation of $esu_{1,nominal}$ and $y_1, sh_1, f_{t1}, f_{y1}$, it is considered
characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TB DY.

$y_1, sh_1, f_{t1}, f_{y1}$, are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_1 = fs = 291.2595$$

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

$$y_2 = 0.00104853$$

$$sh_2 = 0.00335528$$

$$f_{t2} = 349.5114$$

$$f_{y2} = 291.2595$$

$$su_2 = 0.00335528$$

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

$$l_o/l_{o,min} = l_b/l_{b,min} = 0.19435406$$

$$su_2 = 0.4 * esu_{2,nominal}((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu_{2,nominal} = 0.08,$$

For calculation of $esu_{2,nominal}$ and $y_2, sh_2, f_{t2}, f_{y2}$, it is considered
characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TB DY.

$y_1, sh_1, f_{t1}, f_{y1}$, are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_2 = fs = 291.2595$$

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

$$y_v = 0.00104853$$


```

shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
lo/lo,min = lb/ld = 0.19435406
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = fs = 291.2595
    with Esv = Es = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.06985696
    2 = Asl,com/(b*d)*(fs2/fc) = 0.06985696
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04352626
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 35.05152
cc (5A.5, TBDY) = 0.00262167
    c = confinement factor = 1.06217
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.09299842
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09299842
    v = Asl,mid/(b*d)*(fsv/fc) = 0.05794517
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.23522079
Mu = MRc (4.14) = 6.8862E+007
u = su (4.1) = 1.7004869E-005

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.19435406
lb = 300.00
ld = 1543.575
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 14.46154
Mean strength value of all re-bars: fy = 694.45
    t = 1.18462
    s = 0.80
    e = 1.00
cb = 25.00
Ktr = 3.22215
n = 13.00

```

Calculation of Mu1-

```

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.7004869E-005
Mu = 6.8862E+007

```

with full section properties:

$b = 400.00$
 $d = 258.00$
 $d' = 42.00$
 $v = 5.6011789E-005$
 $N = 190.7537$
 $f_c = 33.00$
 $\phi_c (5A.5, \text{TB DY}) = 0.002$
 Final value of ϕ_c : $\phi_c^* = \text{shear_factor} * \text{Max}(\phi_c, \phi_c) = 0.00721688$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TB DY: $\phi_c = 0.00721688$
 $\phi_w (5.4c) = 0.00863449$
 $\phi_{se} ((5.4d), \text{TB DY}) = 0.15672608$
 $\phi_b = 240.00$
 $\phi_h = 340.00$
 $\phi_{i2} = 346400.00$
 $\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00261799$

$\phi_{sh,x} (5.4d) = 0.00349066$
 $A_{sh} = A_{stir} * n_s = 78.53982$
 No stirrups, $n_s = 2.00$
 $b_k = 300.00$

$\phi_{sh,y} (5.4d) = 0.00261799$
 $A_{sh} = A_{stir} * n_s = 78.53982$
 No stirrups, $n_s = 2.00$
 $b_k = 400.00$

$s = 150.00$
 $f_{ywe} = 694.45$
 $f_{ce} = 33.00$
 From ((5.A5), TB DY), TB DY: $\phi_c = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $y_1 = 0.00104853$
 $sh_1 = 0.00335528$
 $ft_1 = 349.5114$
 $fy_1 = 291.2595$
 $su_1 = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $\phi_{lo/lou,min} = \phi_b / \phi_d = 0.19435406$
 $su_1 = 0.4 * \phi_{su1_nominal} ((5.5), \text{TB DY}) = 0.032$
 From table 5A.1, TB DY: $\phi_{su1_nominal} = 0.08$,
 For calculation of $\phi_{su1_nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $\phi_{sy1} = \phi_s / 1.2$, from table 5.1, TB DY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (\phi_b / \phi_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $\phi_{s1} = \phi_s = 291.2595$
 with $E_{s1} = E_s = 200000.00$
 $y_2 = 0.00104853$
 $sh_2 = 0.00335528$
 $ft_2 = 349.5114$
 $fy_2 = 291.2595$
 $su_2 = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $\phi_{lo/lou,min} = \phi_b / \phi_{b,min} = 0.19435406$
 $su_2 = 0.4 * \phi_{su2_nominal} ((5.5), \text{TB DY}) = 0.032$
 From table 5A.1, TB DY: $\phi_{su2_nominal} = 0.08$,
 For calculation of $\phi_{su2_nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $\phi_{sy2} = \phi_s / 1.2$, from table 5.1, TB DY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (\phi_b / \phi_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $\phi_{s2} = \phi_s = 291.2595$
 with $E_{s2} = E_s = 200000.00$
 $y_v = 0.00104853$
 $sh_v = 0.00335528$
 $ft_v = 349.5114$

```

fyv = 291.2595
suv = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lo,min = lb/ld = 0.19435406
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 291.2595
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06985696
2 = Asl,com/(b*d)*(fs2/fc) = 0.06985696
v = Asl,mid/(b*d)*(fsv/fc) = 0.04352626
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 35.05152
cc (5A.5, TBDY) = 0.00262167
c = confinement factor = 1.06217
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09299842
2 = Asl,com/(b*d)*(fs2/fc) = 0.09299842
v = Asl,mid/(b*d)*(fsv/fc) = 0.05794517
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.23522079
Mu = MRc (4.14) = 6.8862E+007
u = su (4.1) = 1.7004869E-005
-----

Calculation of ratio lb/ld
-----
Lap Length: lb/ld = 0.19435406
lb = 300.00
ld = 1543.575
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 14.46154
Mean strength value of all re-bars: fy = 694.45
t = 1.18462
s = 0.80
e = 1.00
cb = 25.00
Ktr = 3.22215
n = 13.00
-----

Calculation of Mu2+
-----

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.7004869E-005
Mu = 6.8862E+007
-----
with full section properties:
b = 400.00
d = 258.00

```

```

d' = 42.00
v = 5.6011789E-005
N = 190.7537
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00721688
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00721688
we (5.4c) = 0.00863449
ase ((5.4d), TBDY) = 0.15672608
bo = 240.00
ho = 340.00
bi2 = 346400.00
psh,min = Min(psh,x , psh,y) = 0.00261799
-----
psh,x (5.4d) = 0.00349066
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 300.00
-----
psh,y (5.4d) = 0.00261799
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
-----
s = 150.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00262167
c = confinement factor = 1.06217
y1 = 0.00104853
sh1 = 0.00335528
ft1 = 349.5114
fy1 = 291.2595
su1 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.19435406
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 = 291.2595
with Es1 = Es = 200000.00
y2 = 0.00104853
sh2 = 0.00335528
ft2 = 349.5114
fy2 = 291.2595
su2 = 0.00335528
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.19435406
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 = 291.2595
with Es2 = Es = 200000.00
yv = 0.00104853
shv = 0.00335528
ftv = 349.5114
fyv = 291.2595
suv = 0.00335528

```

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 0.19435406$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
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, 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 $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fsv = fs = 291.2595$
with $Esv = Es = 200000.00$
 $1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.06985696$
 $2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.06985696$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.04352626$

and confined core properties:

$b = 340.00$
 $d = 228.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 35.05152$
 $cc (5A.5, TBDY) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.09299842$
 $2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.09299842$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.05794517$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su (4.9) = 0.23522079$
 $Mu = MRc (4.14) = 6.8862E+007$
 $u = su (4.1) = 1.7004869E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.19435406$
 $l_b = 300.00$
 $l_d = 1543.575$
Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 14.46154$
Mean strength value of all re-bars: $fy = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 3.22215$
 $n = 13.00$

Calculation of Mu_2 -

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

$u = 1.7004869E-005$
 $Mu = 6.8862E+007$

with full section properties:

$b = 400.00$
 $d = 258.00$
 $d' = 42.00$
 $v = 5.6011789E-005$

$N = 190.7537$
 $f_c = 33.00$
 $\phi_c (5A.5, TBDY) = 0.002$
 Final value of ϕ_c : $\phi_c^* = \text{shear_factor} * \text{Max}(\phi_c, \phi_c) = 0.00721688$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\phi_c = 0.00721688$
 $\phi_w (5.4c) = 0.00863449$
 $\phi_{ase} ((5.4d), TBDY) = 0.15672608$
 $b_o = 240.00$
 $h_o = 340.00$
 $b_i^2 = 346400.00$
 $\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00261799$

$\phi_{sh,x} (5.4d) = 0.00349066$
 $A_{sh} = A_{stir} * n_s = 78.53982$
 No stirrups, $n_s = 2.00$
 $b_k = 300.00$

$\phi_{sh,y} (5.4d) = 0.00261799$
 $A_{sh} = A_{stir} * n_s = 78.53982$
 No stirrups, $n_s = 2.00$
 $b_k = 400.00$

$s = 150.00$
 $f_{ywe} = 694.45$
 $f_{ce} = 33.00$
 From ((5.A.5), TBDY), TBDY: $\phi_c = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $y_1 = 0.00104853$
 $sh_1 = 0.00335528$
 $ft_1 = 349.5114$
 $fy_1 = 291.2595$
 $su_1 = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.19435406$
 $su_1 = 0.4 * \phi_{su1_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $\phi_{su1_nominal} = 0.08$,
 For calculation of $\phi_{su1_nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $f_{sy1} = f_s/1.2$, 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 $f_{s1} = f_s = 291.2595$
 with $E_{s1} = E_s = 200000.00$
 $y_2 = 0.00104853$
 $sh_2 = 0.00335528$
 $ft_2 = 349.5114$
 $fy_2 = 291.2595$
 $su_2 = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.19435406$
 $su_2 = 0.4 * \phi_{su2_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $\phi_{su2_nominal} = 0.08$,
 For calculation of $\phi_{su2_nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $f_{sy2} = f_s/1.2$, 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 $f_{s2} = f_s = 291.2595$
 with $E_{s2} = E_s = 200000.00$
 $y_v = 0.00104853$
 $sh_v = 0.00335528$
 $ft_v = 349.5114$
 $fy_v = 291.2595$
 $suv = 0.00335528$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with

$\text{Shear_factor} = 1.00$
 $\text{lo/lo,min} = \text{lb/ld} = 0.19435406$
 $\text{su} = 0.4 * \text{esuv_nominal} ((5.5), \text{TBDY}) = 0.032$
 From table 5A.1, TBDY: $\text{esuv_nominal} = 0.08$,
 considering characteristic value $\text{fsyv} = \text{fsv}/1.2$, from table 5.1, TBDY
 For calculation of esuv_nominal and yv , shv , ftv , fyv , it is considered
 characteristic value $\text{fsyv} = \text{fsv}/1.2$, from table 5.1, TBDY.
 y1 , sh1 , ft1 , fy1 , are also multiplied by $\text{Min}(1, 1.25 * (\text{lb/ld})^{2/3})$, from 10.3.5, ASCE 41-17.
 with $\text{fsv} = \text{fs} = 291.2595$
 with $\text{Esv} = \text{Es} = 200000.00$
 $1 = \text{Asl,ten}/(\text{b} * \text{d}) * (\text{fs1}/\text{fc}) = 0.06985696$
 $2 = \text{Asl,com}/(\text{b} * \text{d}) * (\text{fs2}/\text{fc}) = 0.06985696$
 $v = \text{Asl,mid}/(\text{b} * \text{d}) * (\text{fsv}/\text{fc}) = 0.04352626$

and confined core properties:

$b = 340.00$
 $d = 228.00$
 $d' = 12.00$
 $\text{fcc} (5A.2, \text{TBDY}) = 35.05152$
 $\text{cc} (5A.5, \text{TBDY}) = 0.00262167$
 $c = \text{confinement factor} = 1.06217$
 $1 = \text{Asl,ten}/(\text{b} * \text{d}) * (\text{fs1}/\text{fc}) = 0.09299842$
 $2 = \text{Asl,com}/(\text{b} * \text{d}) * (\text{fs2}/\text{fc}) = 0.09299842$
 $v = \text{Asl,mid}/(\text{b} * \text{d}) * (\text{fsv}/\text{fc}) = 0.05794517$

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

---->
 $v < \text{vs,y2}$ - LHS eq.(4.5) is satisfied
 ---->
 $\text{su} (4.9) = 0.23522079$
 $\text{Mu} = \text{MRc} (4.14) = 6.8862\text{E}+007$
 $u = \text{su} (4.1) = 1.7004869\text{E}-005$

Calculation of ratio lb/ld

Lap Length: $\text{lb/ld} = 0.19435406$
 $\text{lb} = 300.00$
 $\text{ld} = 1543.575$
 Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $\text{db} = 14.46154$
 Mean strength value of all re-bars: $\text{fy} = 694.45$
 $t = 1.18462$
 $s = 0.80$
 $e = 1.00$
 $\text{cb} = 25.00$
 $\text{Ktr} = 3.22215$
 $n = 13.00$

Calculation of Shear Strength $\text{Vr} = \text{Min}(\text{Vr1}, \text{Vr2}) = 192957.075$

Calculation of Shear Strength at edge 1, $\text{Vr1} = 192957.075$
 $\text{Vr1} = \text{Vn} ((22.5.1.1), \text{ACI 318-14})$

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

From Table (22.5.5.1), ACI 318-14: $\text{Vc} = 88236.482$
 $= 1$ (normal-weight concrete)
 $\text{fc}' = 33.00$, but $\text{fc}'^{0.5} \leq 8.3 \text{ MPa}$ (22.5.3.1, ACI 318-14)
 $\text{pw} = \text{As}/(\text{bw} * \text{d}) = 0.00949023$
 As (tension reinf.) = 911.0619
 $\text{bw} = 400.00$

$d = 240.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 9.6361865E-012$
 $V_u = 2.7041243E-015$
 From (11.5.4.8), ACI 318-14: $V_s = 104720.593$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$
 V_s has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.75$
 $V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$
 From (11-11), ACI 440: $V_s + V_f \leq 366348.956$

Calculation of Shear Strength at edge 2, $V_{r2} = 192957.075$
 $V_{r2} = V_n ((22.5.1.1), \text{ACI } 318-14)$

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

From Table (22.5.5.1), ACI 318-14: $V_c = 88236.482$
 $= 1$ (normal-weight concrete)
 $f'_c = 33.00$, but $f'_c^{0.5} \leq 8.3 \text{ MPa}$ (22.5.3.1, ACI 318-14)
 $p_w = A_s / (b_w \cdot d) = 0.00949023$
 A_s (tension reinf.) = 911.0619
 $b_w = 400.00$
 $d = 240.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 4.6338743E-012$
 $V_u = 2.7041243E-015$
 From (11.5.4.8), ACI 318-14: $V_s = 104720.593$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 150.00$
 V_s has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.75$
 $V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$
 From (11-11), ACI 440: $V_s + V_f \leq 366348.956$

End Of Calculation of Shear Capacity ratio for element: beam B1 of floor 1
 At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam B1 of floor 1
 At local axis: 3
 Integration Section: (b)
 Section Type: rcars

Constant Properties

Knowledge Factor, $= 1.00$
 Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
 Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
 Consequently:
 New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
 New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$
 Concrete Elasticity, $E_c = 26999.444$
 Steel Elasticity, $E_s = 200000.00$
 Section Height, $H = 400.00$
 Section Width, $W = 300.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 1850.00$
 Secondary Member
 Smooth Bars
 Ductile Steel
 With Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_b = 300.00$
No FRP Wrapping

Stepwise Properties

Bending Moment, $M = -5.9205937E-011$
Shear Force, $V2 = 7.2286192E-014$
Shear Force, $V3 = 11778.568$
Axial Force, $F = -701.3709$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_t = 923.6282$
-Compression: $As_c = 1218.938$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{t,ten} = 816.8141$
-Compression: $As_{c,com} = 816.8141$
-Middle: $As_{mid} = 508.938$
Mean Diameter of Tension Reinforcement, $Db_L = 14.40$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.0225644$
 $u = y + p = 0.0225644$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.0025644$ ((4.29), Biskinis Phd))
 $M_y = 6.0629E+007$
 $L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 925.00
From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 7.2898E+012$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 7.4481424E-006$
with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b / l_d)^{2/3}) = 270.3814$
 $d = 258.00$
 $y = 0.29647576$
 $A = 0.02078644$
 $B = 0.01209566$
with $p_t = 0.00791487$
 $p_c = 0.00791487$
 $p_v = 0.00493157$
 $N = 701.3709$
 $b = 400.00$
 $" = 0.1627907$
 $y_{comp} = 2.8783181E-005$
with $f_c = 33.00$
 $E_c = 26999.444$
 $y = 0.29626007$
 $A = 0.02074585$
 $B = 0.01207052$
with $E_s = 200000.00$

Calculation of ratio l_b / l_d

Lap Length: $l_d / l_{d,min} = 0.24294258$
 $l_b = 300.00$

$$l_d = 1234.86$$

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

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)

$$= 1$$

$$d_b = 14.46154$$

Mean strength value of all re-bars: $f_y = 555.56$

$$t = 1.18462$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 3.22215$$

$$n = 13.00$$

- Calculation of p -

From table 10-7: $p = 0.02$

with:

- Condition iv occurred

Beam controlled by inadequate embedment into beam-column joint:

($l_b/l_d < 1$ and With Lapping in the Vicinity of the End Regions

- Condition i occurred

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

shear control ratio $V_p/V_o = 0.38581165$

- Transverse Reinforcement: NC

- Stirrup Spacing $> d/3$

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

$$= -2.1161258E-021$$

- Stirrup Spacing $> d/2$

$$d = 258.00$$

$$s = 150.00$$

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

$V_s = 139627.457$, already given in calculation of shear control ratio

design Shear = $7.2286192E-014$

- ($\rho_t - \rho_c$)/ $\rho_{bal} = -0.16792835$

$$= A_{st}/(b_w \cdot d) = 0.00894989$$

Tension Reinf Area: $A_{st} = 923.6282$

$$\rho_c = A_{sc}/(b_w \cdot d) = 0.01181141$$

Compression Reinf Area: $A_{sc} = 1218.938$

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

$$f_c = 33.00$$

$$f_y = 555.56$$

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

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

$$\gamma = 0.0027778$$

- $V/(b_w \cdot d \cdot f_c^{0.5}) = 1.4683917E-018$, NOTE: units in lb & in

$$b_w = 400.00$$

End Of Calculation of Chord Rotation Capacity for element: beam B1 of floor 1

At local axis: 3

Integration Section: (b)