

Detailed Member Calculations

Units: N&mm

Regulation: ASCE 41-17

Calculation No. 1

beam B1, Floor 1

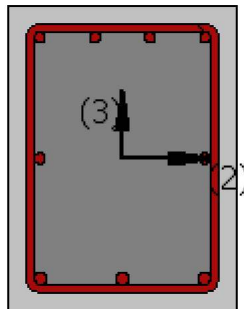
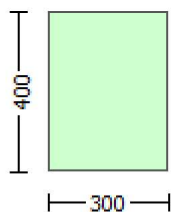
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity 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, $\gamma = 0.90$

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

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$
Section Height, $H = 400.00$
Section Width, $W = 300.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 1850.00$
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with $l_o/l_{ou,min} = l_b/l_d = 0.30$
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, $M_a = -7.2037543E-011$
Shear Force, $V_a = -2.9102230E-014$
EDGE -B-
Bending Moment, $M_b = 1.8189791E-011$
Shear Force, $V_b = 2.9102230E-014$
BOTH EDGES
Axial Force, $F = -459.9979$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 603.1858$
-Compression: $A_{sc} = 923.6282$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten} = 508.938$
-Compression: $A_{st,com} = 508.938$
-Middle: $A_{st,mid} = 508.938$
Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 14.66667$

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)
 $\rho_w = A_s/(b_w \cdot d) = 0.00628319$
 A_s (tension reinf.) = 603.1858
 $b_w = 400.00$
 $d = 240.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 7.2037543E-011$
 $V_u = 2.9102230E-014$
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

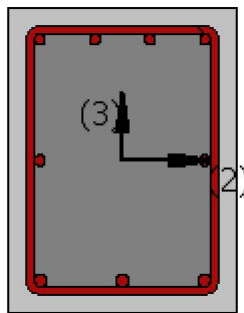
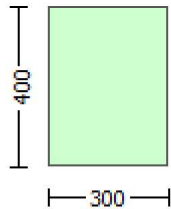
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

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, $\phi = 0.90$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

#####

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 = 1.00

Element Length, $L = 1850.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{ou,min} = 0.30$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 2740.264$

EDGE -B-

Shear Force, $V_b = 2740.264$

BOTH EDGES

Axial Force, $F = -189.411$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 603.1858$

-Compression: $As_c = 923.6282$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 603.1858$

-Compression: $As_{l,com} = 615.7522$

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

Calculation of Shear Capacity ratio , $V_e/V_r = 0.39580698$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 112670.646$ with

$M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 1.0175E+008$

$Mu_{1+} = 9.9812E+007$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$Mu_{1-} = 1.0175E+008$, 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

$M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 1.0162E+008$

$Mu_{2+} = 9.9934E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination

$Mu_{2-} = 1.0162E+008$, 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

$V_1 = 2740.264$, is the shear force acting at edge 1 for the static loading combination

$V_2 = 2740.264$, 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:

$\phi_u = 1.7580246E-005$

$M_u = 9.9812E+007$

with full section properties:

$b = 300.00$

$d = 357.00$

$d' = 42.00$

$v = 5.3592212E-005$

$N = 189.411$

$f_c = 33.00$

ϕ_o (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_o) = 0.00553582$

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

From (5.4b), TBDY: $\phi_u = 0.00553582$

w_e (5.4c) = 0.00259035

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

$b_o = 240.00$

$h_o = 340.00$

$bi_2 = 346400.00$

psh,min = Min(psh,x , psh,y) = 0.00261799
 Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh,x (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 = 0.002
 c = confinement factor = 1.00
 y1 = 0.00140044
 sh1 = 0.0044814
 ft1 = 466.8167
 fy1 = 389.0139
 su1 = 0.00512
 using (30) in Biskinis/Fardis (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 = 0.30
 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 = 389.0139
 with Es1 = Es = 200000.00
 y2 = 0.00140044
 sh2 = 0.0044814
 ft2 = 466.8167
 fy2 = 389.0139
 su2 = 0.00512
 using (30) in Biskinis/Fardis (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 = 0.30
 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 = 389.0139
 with Es2 = Es = 200000.00
 yv = 0.00140044
 shv = 0.0044814
 ftv = 466.8167
 fyv = 389.0139
 suv = 0.00512
 using (30) in Biskinis/Fardis (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 = 0.30
 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 = 389.0139

with $E_s = E_s = 200000.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.06639156$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.06777471$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.03388736$
and confined core properties:
 $b = 240.00$
 $d = 327.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.09060316$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.09249072$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.04624536$
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
--->
 $su (4.9) = 0.18421297$
 $Mu = MR_c (4.14) = 9.9812E+007$
 $u = su (4.1) = 1.7580246E-005$

Calculation of ratio l_b/d

Inadequate Lap Length with $l_b/d = 0.30$

Calculation of $Mu1$ -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.7569691E-005$
 $Mu = 1.0175E+008$

with full section properties:

$b = 300.00$
 $d = 358.00$
 $d' = 43.00$
 $v = 5.3442513E-005$
 $N = 189.411$
 $f_c = 33.00$
 $co (5A.5, TBDY) = 0.002$
Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00553582$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $cu = 0.00553582$
 $w_e (5.4c) = 0.00259035$
 $a_{se} ((5.4d), TBDY) = 0.15672608$
 $bo = 240.00$
 $ho = 340.00$
 $bi2 = 346400.00$
 $p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00261799$
Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

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

```

s = 150.00
fywe = 694.45
fce = 33.00
From ((5A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30
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 = 389.0139
with Es1 = Es = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
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 = 389.0139
with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30
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 = 389.0139
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0675854
2 = Asl,com/(b*d)*(fs2/fc) = 0.06620611
v = Asl,mid/(b*d)*(fsv/fc) = 0.0337927
and confined core properties:
b = 240.00
d = 328.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09220874
2 = Asl,com/(b*d)*(fs2/fc) = 0.09032693

```

$$v = A_{sl, mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.04610437$$

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

--->

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

--->

$$s_u(4.9) = 0.18600297$$

$$\mu_u = M_{Rc}(4.14) = 1.0175E+008$$

$$u = s_u(4.1) = 1.7569691E-005$$

Calculation of ratio I_b/I_d

Inadequate Lap Length with $I_b/I_d = 0.30$

Calculation of μ_{u2+}

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

$$u = 1.7539903E-005$$

$$\mu_u = 9.9934E+007$$

with full section properties:

$$b = 300.00$$

$$d = 358.00$$

$$d' = 43.00$$

$$v = 5.3442513E-005$$

$$N = 189.411$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu_{cu}: \mu_{cu}^* = \text{shear_factor} \cdot \text{Max}(\mu_{cu}, \mu_{cc}) = 0.00553582$$

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

$$\text{From (5.4b), TBDY: } \mu_{cu} = 0.00553582$$

$$\mu_{we}(5.4c) = 0.00259035$$

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

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

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

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

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

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

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

$$b_k = 300.00$$

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

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

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

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

Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $su_1 = 0.4 * esu_1_{nominal} ((5.5), TBDY) = 0.032$
 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 $fs_1 = fs = 389.0139$
 with $Es_1 = Es = 200000.00$
 $y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 466.8167$
 $fy_2 = 389.0139$
 $su_2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_b,min = 0.30$
 $su_2 = 0.4 * esu_2_{nominal} ((5.5), TBDY) = 0.032$
 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 $fs_2 = fs = 389.0139$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 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 $fsv = fs = 389.0139$
 with $Esv = Es = 200000.00$
 $1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.06620611$
 $2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.0675854$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.0337927$

and confined core properties:

$b = 240.00$
 $d = 328.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.09032693$
 $2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.09220874$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.04610437$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{sy2}$ - LHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.18462058$
 $Mu = MRc (4.14) = 9.9934E+007$
 $u = su (4.1) = 1.7539903E-005$

 Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_2 -

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

$$\mu = 1.7610316E-005$$

$$\mu_u = 1.0162E+008$$

with full section properties:

$$b = 300.00$$

$$d = 357.00$$

$$d' = 42.00$$

$$v = 5.3592212E-005$$

$$N = 189.411$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu_u: \mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \rho) = 0.00553582$$

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

$$\text{From (5.4b), TB DY: } \mu_u = 0.00553582$$

$$\mu_u (5.4c) = 0.00259035$$

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

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

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

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

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

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

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

$$b_k = 300.00$$

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

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

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$f_{t1} = 466.8167$$

$$f_{y1} = 389.0139$$

$$\mu_{u1} = 0.00512$$

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

$$l_o/l_{ou,min} = l_b/l_d = 0.30$$

$$\mu_{u1} = 0.4 * \mu_{u1,nominal} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } \mu_{u1,nominal} = 0.08$$

For calculation of $\mu_{u1,nominal}$ and $y_1, sh_1, f_{t1}, f_{y1}$, it is considered characteristic value $f_{sy1} = f_s/1.2$, from table 5.1, 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.

$$\text{with } f_{s1} = f_s = 389.0139$$

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

$$y_2 = 0.00140044$$

$$sh_2 = 0.0044814$$

$$f_{t2} = 466.8167$$

$$f_{y2} = 389.0139$$

```

su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
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 = 389.0139
with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30
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 = 389.0139
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06777471
2 = Asl,com/(b*d)*(fs2/fc) = 0.06639156
v = Asl,mid/(b*d)*(fsv/fc) = 0.03388736
and confined core properties:
b = 240.00
d = 327.00
d' = 12.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09249072
2 = Asl,com/(b*d)*(fs2/fc) = 0.09060316
v = Asl,mid/(b*d)*(fsv/fc) = 0.04624536
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18560594
Mu = MRc (4.14) = 1.0162E+008
u = su (4.1) = 1.7610316E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 284660.584$

Calculation of Shear Strength at edge 1, $V_{r1} = 284660.584$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14: $V_c = 98490.641$
 $= 1$ (normal-weight concrete)
 $f'_c = 33.00$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s/(b_w \cdot d) = 0.00628319$
 A_s (tension reinf.) = 603.1858
 $b_w = 300.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 1.00$
 $M_u = 69262.055$
 $V_u = 2740.264$
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, $V_{r2} = 284660.584$
 $V_{r2} = V_n$ ((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: $V_c = 98490.641$
 $= 1$ (normal-weight concrete)
 $f'_c = 33.00$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s/(b_w \cdot d) = 0.00628319$
 A_s (tension reinf.) = 603.1858
 $b_w = 300.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 1.00$
 $M_u = 69262.055$
 $V_u = 2740.264$
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, $\phi = 0.90$
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$

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 = 1.00
 Element Length, $L = 1850.00$
 Primary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Inadequate Lap Length with $l_o/l_{o,min} = 0.30$
 No FRP Wrapping

Stepwise Properties

At local axis: 2
 EDGE -A-
 Shear Force, $V_a = -8.6414578E-021$
 EDGE -B-
 Shear Force, $V_b = 8.6414578E-021$
 BOTH EDGES
 Axial Force, $F = -189.411$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 603.1858$
 -Compression: $As_c = 923.6282$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 508.938$
 -Compression: $As_{c,com} = 508.938$
 -Middle: $As_{mid} = 508.938$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.37228966$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 71835.924$
 with
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 6.6448E+007$
 $\mu_{u1+} = 6.6448E+007$, 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
 $\mu_{u1-} = 6.6448E+007$, 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
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 6.6448E+007$
 $\mu_{u2+} = 6.6448E+007$, 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
 $\mu_{u2-} = 6.6448E+007$, 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
 $V_1 = -8.6414578E-021$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 8.6414578E-021$, 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:
 $\phi_u = 2.4749691E-005$
 $M_u = 6.6448E+007$

with full section properties:

$b = 400.00$
 $d = 258.00$
 $d' = 42.00$

$v = 5.5617499E-005$
 $N = 189.411$
 $fc = 33.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = shear_factor * Max(cu, cc) = 0.00553582$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.00553582$
 $we (5.4c) = 0.00259035$
 $ase ((5.4d), TBDY) = 0.15672608$
 $bo = 240.00$
 $ho = 340.00$
 $bi2 = 346400.00$
 $psh,min = Min(psh,x, psh,y) = 0.00261799$
 Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

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

$s = 150.00$
 $fywe = 694.45$
 $fce = 33.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = confinement\ factor = 1.00$
 $y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 466.8167$
 $fy1 = 389.0139$
 $su1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/l_d = 0.30$
 $su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032$
 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 $fs1 = fs = 389.0139$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 466.8167$
 $fy2 = 389.0139$
 $su2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/l_b,min = 0.30$
 $su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032$
 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 $fs2 = fs = 389.0139$
 with $Es2 = Es = 200000.00$
 $yv = 0.00140044$
 $shv = 0.0044814$
 $ftv = 466.8167$
 $fyv = 389.0139$

$suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lo_{u,min} = lb/d = 0.30$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$
 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 $fsv = fs = 389.0139$
 with $Esv = Es = 200000.00$
 $1 = Asl_{ten}/(b*d) * (fs1/fc) = 0.05813483$
 $2 = Asl_{com}/(b*d) * (fs2/fc) = 0.05813483$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.05813483$
 and confined core properties:
 $b = 340.00$
 $d = 228.00$
 $d' = 12.00$
 $fcc (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_{ten}/(b*d) * (fs1/fc) = 0.07739312$
 $2 = Asl_{com}/(b*d) * (fs2/fc) = 0.07739312$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.07739312$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < vs_{y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.19817337$
 $Mu = MRc (4.14) = 6.6448E+007$
 $u = su (4.1) = 2.4749691E-005$

Calculation of ratio lb/d

Inadequate Lap Length with $lb/d = 0.30$

Calculation of $Mu1$ -

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

$u = 2.4749691E-005$

$Mu = 6.6448E+007$

with full section properties:

$b = 400.00$

$d = 258.00$

$d' = 42.00$

$v = 5.5617499E-005$

$N = 189.411$

$fc = 33.00$

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

Final value of cu : $cu^* = shear_factor * Max(cu, cc) = 0.00553582$

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

From (5.4b), TBDY: $cu = 0.00553582$

$we (5.4c) = 0.00259035$

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

$bo = 240.00$

$ho = 340.00$

$bi2 = 346400.00$

$psh_{min} = Min(psh_x, psh_y) = 0.00261799$

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

psh,x (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 = 0.002
c = confinement factor = 1.00

y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512

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

lo/lou,min = lb/lb = 0.30

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 = 389.0139

with Es1 = Es = 200000.00

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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 = 389.0139

with Es2 = Es = 200000.00

yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512

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

lo/lou,min = lb/lb = 0.30

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 = 389.0139

with Esv = Es = 200000.00

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.05813483$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.05813483$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05813483$$

and confined core properties:

$$b = 340.00$$

$$d = 228.00$$

$$d' = 12.00$$

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

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

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

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.07739312$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.07739312$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.07739312$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$s_u (4.9) = 0.19817337$$

$$\mu_u = M_{Rc} (4.14) = 6.6448E+007$$

$$u = s_u (4.1) = 2.4749691E-005$$

Calculation of ratio I_b/I_d

Inadequate Lap Length with $I_b/I_d = 0.30$

Calculation of μ_{u2+}

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

$$u = 2.4749691E-005$$

$$\mu_u = 6.6448E+007$$

with full section properties:

$$b = 400.00$$

$$d = 258.00$$

$$d' = 42.00$$

$$v = 5.5617499E-005$$

$$N = 189.411$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu_u: \mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, cc) = 0.00553582$$

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

$$\text{From (5.4b), TBDY: } \mu_u = 0.00553582$$

$$\mu_{ue} (5.4c) = 0.00259035$$

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

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

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

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

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

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

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

$$b_k = 300.00$$

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

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

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

$$b_k = 400.00$$

```

s = 150.00
fywe = 694.45
fce = 33.00
From ((5.A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.30
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 = 389.0139
with Es1 = Es = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
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 = 389.0139
with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.30
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 = 389.0139
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05813483
2 = Asl,com/(b*d)*(fs2/fc) = 0.05813483
v = Asl,mid/(b*d)*(fsv/fc) = 0.05813483
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07739312
2 = Asl,com/(b*d)*(fs2/fc) = 0.07739312
v = Asl,mid/(b*d)*(fsv/fc) = 0.07739312

```

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) = 0.19817337

$M_u = M_{Rc}$ (4.14) = 6.6448E+007

$u = \mu_u$ (4.1) = 2.4749691E-005

Calculation of ratio I_b/I_d

Inadequate Lap Length with $I_b/I_d = 0.30$

Calculation of μ_{u2} -

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

$u = 2.4749691E-005$

$M_u = 6.6448E+007$

with full section properties:

$b = 400.00$

$d = 258.00$

$d' = 42.00$

$v = 5.5617499E-005$

$N = 189.411$

$f_c = 33.00$

ϕ_c (5A.5, TBDY) = 0.002

Final value of ϕ_{cu} : $\phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_c) = 0.00553582$

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

From (5.4b), TBDY: $\phi_{cu} = 0.00553582$

ϕ_{we} (5.4c) = 0.00259035

ϕ_{ase} ((5.4d), TBDY) = 0.15672608

$b_o = 240.00$

$h_o = 340.00$

$b_i^2 = 346400.00$

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

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

$\phi_{psh,x}$ (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 ((5A5), TBDY), TBDY: $\phi_c = 0.002$

c = confinement factor = 1.00

$y_1 = 0.00140044$

$sh_1 = 0.0044814$

$ft_1 = 466.8167$

$fy_1 = 389.0139$

$\mu_{u1} = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30
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 = 389.0139
with Es1 = Es = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
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 = 389.0139
with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30
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 = 389.0139
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05813483
2 = Asl,com/(b*d)*(fs2/fc) = 0.05813483
v = Asl,mid/(b*d)*(fsv/fc) = 0.05813483
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07739312
2 = Asl,com/(b*d)*(fs2/fc) = 0.07739312
v = Asl,mid/(b*d)*(fsv/fc) = 0.07739312
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19817337
Mu = MRc (4.14) = 6.6448E+007
u = su (4.1) = 2.4749691E-005

```

Calculation of ratio lb/d

Inadequate Lap Length with lb/d = 0.30

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)
 $\rho_w = A_s / (b_w \cdot d) = 0.00628319$
 A_s (tension reinf.) = 603.1858
 $b_w = 400.00$
 $d = 240.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 3.4215184E-013$
 $V_u = 8.6414578E-021$

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)
 $\rho_w = A_s / (b_w \cdot d) = 0.00628319$
 A_s (tension reinf.) = 603.1858
 $b_w = 400.00$
 $d = 240.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 3.4215797E-013$
 $V_u = 8.6414578E-021$

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, $\phi = 0.90$

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

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 1850.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_b/l_d = 0.30$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 4.3814E+006$

Shear Force, $V_2 = -2.9102230E-014$

Shear Force, $V_3 = -2011.333$

Axial Force, $F = -459.9979$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 603.1858$

-Compression: $A_{sc} = 923.6282$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{st,ten} = 603.1858$

-Compression: $A_{st,com} = 615.7522$

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

Mean Diameter of Tension Reinforcement, $D_bL = 16.00$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^* u = 0.00895818$

$u = y + p = 0.00895818$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00395818$ ((4.29), Biskinis Phd))

$M_y = 7.0646E+007$

$L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 2178.341

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 -

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

$y_{ten} = 5.8345902E-006$

with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b/l_d)^{2/3}) = 311.2112$

$d = 357.00$

$y = 0.25295531$

$A = 0.01426977$

$B = 0.00792861$

with $pt = 0.00563199$

$pc = 0.00574932$

$$p_v = 0.00287466$$

$$N = 459.9979$$

$$b = 300.00$$

$$" = 0.11764706$$

$$y_{comp} = 2.4377991E-005$$

$$\text{with } f_c = 33.00$$

$$E_c = 26999.444$$

$$y = 0.25279326$$

$$A = 0.01424621$$

$$B = 0.00791481$$

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

Calculation of ratio I_b/I_d

Inadequate Lap Length with $I_b/I_d = 0.30$

- Calculation of p -

From table 10-7: $p = 0.005$

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 $V_p/V_o = 0.39580698$

- Transverse Reinforcement: NC

- Stirrup Spacing $> d/3$

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

$$= 4.5852551E-005$$

- Stirrup Spacing $\leq d/2$

$$d = 357.00$$

$$s = 150.00$$

- 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 = 2011.333

- ($\rho_t - \rho_t'$)/ $\rho_{bal} = -0.17558466$

$$= A_{st}/(b_w \cdot d) = 0.00563199$$

Tension Reinf Area: $A_{st} = 603.1858$

$$\rho_t' = A_{sc}/(b_w \cdot d) = 0.00862398$$

Compression Reinf Area: $A_{sc} = 923.6282$

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): $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + \gamma) = 0.51922877$

$$\gamma = 0.0027778$$

- $V/(b_w \cdot d \cdot f_c^{0.5}) = 0.03936958$, 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

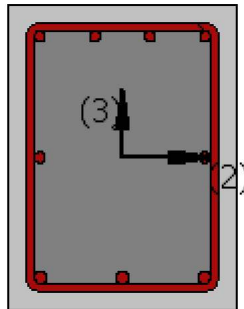
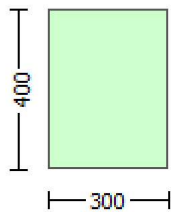
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: Start

Local Axis: (3)



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

At local axis: 3

Integration Section: (a)

Section Type: rcars

Constant Properties

Knowledge Factor, $\gamma = 0.90$

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

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 1850.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{ou,min} = l_b/l_d = 0.30$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 4.3814E+006$

Shear Force, $V_a = -2011.333$
 EDGE -B-
 Bending Moment, $M_b = 4.4091E+006$
 Shear Force, $V_b = 7491.862$
 BOTH EDGES
 Axial Force, $F = -459.9979$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{st} = 603.1858$
 -Compression: $A_{sc} = 923.6282$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{st,ten} = 603.1858$
 -Compression: $A_{sc,com} = 615.7522$
 -Middle: $A_{st,mid} = 307.8761$
 Mean Diameter of Tension Reinforcement, $D_{bL,ten} = 16.00$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 245857.952$
 V_n ((22.5.1.1), ACI 318-14) = 245857.952

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: $V_c = 78306.344$
 = 1 (normal-weight concrete)
 $f'_c = 25.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00628319$
 A_s (tension reinf.) = 603.1858
 $b_w = 300.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 0.14690078$
 $M_u = 4.3814E+006$
 $V_u = 2011.333$
 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. 4

beam B1, Floor 1

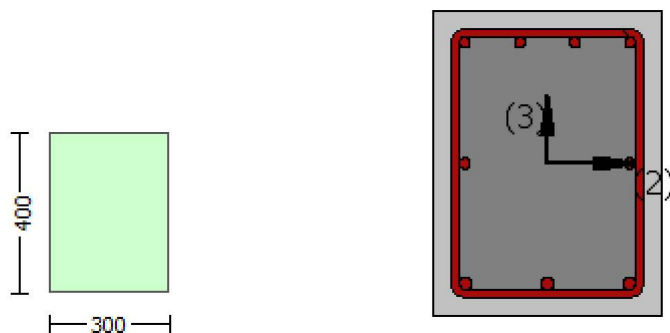
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (ϕ_u)

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, $\phi = 0.90$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

#####

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 = 1.00

Element Length, $L = 1850.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{ou,min} = 0.30$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 2740.264$

EDGE -B-

Shear Force, $V_b = 2740.264$
 BOTH EDGES
 Axial Force, $F = -189.411$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 603.1858$
 -Compression: $As_c = 923.6282$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 603.1858$
 -Compression: $As_{c,com} = 615.7522$
 -Middle: $As_{mid} = 307.8761$

 Calculation of Shear Capacity ratio, $V_e/V_r = 0.39580698$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 112670.646$
 with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 1.0175E+008$
 $\mu_{u1+} = 9.9812E+007$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
 which is defined for the static loading combination
 $\mu_{u1-} = 1.0175E+008$, 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
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 1.0162E+008$
 $\mu_{u2+} = 9.9934E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
 which is defined for the the static loading combination
 $\mu_{u2-} = 1.0162E+008$, 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
 $V_1 = 2740.264$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 2740.264$, is the shear force acting at edge 2 for the the static loading combination

 Calculation of μ_{u1+}

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

$\mu_u = 1.7580246E-005$
 $\mu_u = 9.9812E+007$

 with full section properties:

$b = 300.00$
 $d = 357.00$
 $d' = 42.00$
 $v = 5.3592212E-005$
 $N = 189.411$
 $f_c = 33.00$
 $\phi_c (5A.5, \text{TB DY}) = 0.002$
 Final value of ϕ_c : $\phi_c^* = \text{shear_factor} \cdot \text{Max}(\phi_c, \phi_c) = 0.00553582$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TB DY: $\phi_c = 0.00553582$
 $\phi_w (5.4c) = 0.00259035$
 $\phi_{se} ((5.4d), \text{TB DY}) = 0.15672608$
 $b_o = 240.00$
 $h_o = 340.00$
 $b_{i2} = 346400.00$
 $\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00261799$
 Expression ((5.4d), TB DY) for $\phi_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without
 earthquake detailing (90° closed stirrups)

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

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 = 0.002
c = confinement factor = 1.00

y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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 = 389.0139

with Es1 = Es = 200000.00

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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 = 389.0139

with Es2 = Es = 200000.00

yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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 = 389.0139

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.06639156

2 = Asl,com/(b*d)*(fs2/fc) = 0.06777471

v = Asl,mid/(b*d)*(fsv/fc) = 0.03388736

and confined core properties:

b = 240.00
d = 327.00
d' = 12.00

```

fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09060316
2 = Asl,com/(b*d)*(fs2/fc) = 0.09249072
v = Asl,mid/(b*d)*(fsv/fc) = 0.04624536
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18421297
Mu = MRc (4.14) = 9.9812E+007
u = su (4.1) = 1.7580246E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

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

u = 1.7569691E-005

Mu = 1.0175E+008

with full section properties:

b = 300.00

d = 358.00

d' = 43.00

v = 5.3442513E-005

N = 189.411

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00553582

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

From (5.4b), TBDY: cu = 0.00553582

we (5.4c) = 0.00259035

ase ((5.4d), TBDY) = 0.15672608

bo = 240.00

ho = 340.00

bi2 = 346400.00

psh,min = Min(psh,x , psh,y) = 0.00261799

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

psh,x (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 = 0.002

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

```

ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
    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 = 389.0139
    with Es1 = Es = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
    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 = 389.0139
    with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
    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 = 389.0139
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0675854
2 = Asl,com/(b*d)*(fs2/fc) = 0.06620611
v = Asl,mid/(b*d)*(fsv/fc) = 0.0337927
and confined core properties:
b = 240.00
d = 328.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.09220874
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09032693
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04610437
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18600297
Mu = MRc (4.14) = 1.0175E+008

```

$$u = su(4.1) = 1.7569691E-005$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_{2+}

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

$$u = 1.7539903E-005$$

$$\mu = 9.9934E+007$$

with full section properties:

$$b = 300.00$$

$$d = 358.00$$

$$d' = 43.00$$

$$v = 5.3442513E-005$$

$$N = 189.411$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu_c, \mu_s) = 0.00553582$$

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

$$\text{From (5.4b), TB DY: } \mu_c = 0.00553582$$

$$\mu_s(5.4c) = 0.00259035$$

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

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

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

Expression ((5.4d), TB DY) for $\mu_{s,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

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

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

$$b_k = 300.00$$

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

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

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

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

$$l_o/l_{o,min} = l_b/l_d = 0.30$$

$$su_1 = 0.4 * su_{1,nominal}((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } su_{1,nominal} = 0.08,$$

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

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

$$\text{with } fs_1 = fs = 389.0139$$

```

with Es1 = Es = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
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 = 389.0139
with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30
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 = 389.0139
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06620611
2 = Asl,com/(b*d)*(fs2/fc) = 0.0675854
v = Asl,mid/(b*d)*(fsv/fc) = 0.0337927
and confined core properties:
b = 240.00
d = 328.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09032693
2 = Asl,com/(b*d)*(fs2/fc) = 0.09220874
v = Asl,mid/(b*d)*(fsv/fc) = 0.04610437
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18462058
Mu = MRc (4.14) = 9.9934E+007
u = su (4.1) = 1.7539903E-005

```

Calculation of ratio lb/d

Inadequate Lap Length with lb/d = 0.30

Calculation of Mu2-

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

$$\phi_u = 1.7610316E-005$$

$$\mu_u = 1.0162E+008$$

with full section properties:

$$b = 300.00$$

$$d = 357.00$$

$$d' = 42.00$$

$$v = 5.3592212E-005$$

$$N = 189.411$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00553582$$

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

$$\text{From (5.4b), TB DY: } \phi_{cu} = 0.00553582$$

$$\phi_{we} (5.4c) = 0.00259035$$

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

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_i^2 = 346400.00$$

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

Expression ((5.4d), TB DY) for $\phi_{psh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

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

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

$$b_k = 300.00$$

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

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

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$f_{t1} = 466.8167$$

$$f_{y1} = 389.0139$$

$$su_1 = 0.00512$$

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

$$l_o/l_{ou,min} = l_b/l_d = 0.30$$

$$su_1 = 0.4 * esu1_{nominal} ((5.5), \text{TB DY}) = 0.032$$

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

For calculation of $esu1_{nominal}$ and y_1 , sh_1 , f_{t1} , f_{y1} , it is considered
characteristic value $f_{s1} = f_s/1.2$, from table 5.1, TB DY.

$$y_1, sh_1, f_{t1}, f_{y1}, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b/l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } f_{s1} = f_s = 389.0139$$

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

$$y_2 = 0.00140044$$

$$sh_2 = 0.0044814$$

$$f_{t2} = 466.8167$$

$$f_{y2} = 389.0139$$

$$su_2 = 0.00512$$

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

$$l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$$

$$su_2 = 0.4 * esu2_{nominal} ((5.5), \text{TB DY}) = 0.032$$

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

For calculation of $esu2_{nominal}$ and y_2 , sh_2 , f_{t2} , f_{y2} , it is considered

characteristic value $f_{sy2} = f_{s2}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, f_{y1} , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{s2} = f_s = 389.0139$
 with $E_{s2} = E_s = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $f_{yv} = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 0.30$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 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, 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 $f_{sv} = f_s = 389.0139$
 with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.06777471$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.06639156$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.03388736$
 and confined core properties:
 $b = 240.00$
 $d = 327.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.09249072$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.09060316$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.04624536$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.18560594$
 $Mu = MRc (4.14) = 1.0162E+008$
 $u = su (4.1) = 1.7610316E-005$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 284660.584$

Calculation of Shear Strength at edge 1, $V_{r1} = 284660.584$
 $V_{r1} = V_n ((22.5.1.1), ACI 318-14)$

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: $V_c = 98490.641$
 $= 1$ (normal-weight concrete)
 $f'_c = 33.00$, but $f_c^{0.5} \leq 8.3 \text{ MPa}$ (22.5.3.1, ACI 318-14)
 $p_w = A_s/(b_w \cdot d) = 0.00628319$
 A_s (tension reinf.) = 603.1858
 $b_w = 300.00$
 $d = 320.00$
 $V_u \cdot d / Mu < 1 = 1.00$

$$Mu = 69262.055$$

$$Vu = 2740.264$$

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

$$Av = 157079.633$$

$$fy = 555.56$$

$$s = 150.00$$

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

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

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

Calculation of Shear Strength at edge 2, $Vr2 = 284660.584$

$$Vr2 = Vn \text{ ((22.5.1.1), ACI 318-14)}$$

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).

$$\text{From Table (22.5.5.1), ACI 318-14: } Vc = 98490.641$$

= 1 (normal-weight concrete)

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

$$pw = As / (bw \cdot d) = 0.00628319$$

$$As \text{ (tension reinf.)} = 603.1858$$

$$bw = 300.00$$

$$d = 320.00$$

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

$$Mu = 69262.055$$

$$Vu = 2740.264$$

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

$$Av = 157079.633$$

$$fy = 555.56$$

$$s = 150.00$$

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

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

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

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

$$\text{Knowledge Factor, } \phi = 0.90$$

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

Consequently:

$$\text{New material of Primary Member: Concrete Strength, } fc = fcm = 33.00$$

$$\text{New material of Primary Member: Steel Strength, } fs = fsm = 555.56$$

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

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

#####

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

$$\text{New material: Steel Strength, } fs = 1.25 \cdot fsm = 694.45$$

#####

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

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

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

$$\text{Mean Confinement Factor overall section} = 1.00$$

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

Primary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with $l_o/l_{ou,min} = 0.30$
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = -8.6414578E-021$
EDGE -B-
Shear Force, $V_b = 8.6414578E-021$
BOTH EDGES
Axial Force, $F = -189.411$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $Asl_t = 603.1858$
-Compression: $Asl_c = 923.6282$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $Asl_{ten} = 508.938$
-Compression: $Asl_{com} = 508.938$
-Middle: $Asl_{mid} = 508.938$

Calculation of Shear Capacity ratio , $V_e/V_r = 0.37228966$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 71835.924$
with
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 6.6448E+007$
 $Mu_{1+} = 6.6448E+007$, 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
 $Mu_{1-} = 6.6448E+007$, 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
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 6.6448E+007$
 $Mu_{2+} = 6.6448E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
 $Mu_{2-} = 6.6448E+007$, 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
 $V_1 = -8.6414578E-021$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 8.6414578E-021$, 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:
 $\phi_u = 2.4749691E-005$
 $M_u = 6.6448E+007$

with full section properties:

$b = 400.00$
 $d = 258.00$
 $d' = 42.00$
 $v = 5.5617499E-005$
 $N = 189.411$
 $f_c = 33.00$
 $\phi_o (5A.5, TBDY) = 0.002$
Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_o) = 0.00553582$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\phi_u = 0.00553582$
we (5.4c) = 0.00259035

$ase((5.4d), TBDY) = 0.15672608$
 $bo = 240.00$
 $ho = 340.00$
 $bi2 = 346400.00$
 $psh,min = \text{Min}(psh,x, psh,y) = 0.00261799$
 Expression $((5.4d), TBDY)$ for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

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

$s = 150.00$
 $fywe = 694.45$
 $fce = 33.00$
 From $((5.A5), TBDY)$, $TBDY$: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 466.8167$
 $fy1 = 389.0139$
 $su1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/d = 0.30$
 $su1 = 0.4*esu1_nominal((5.5), TBDY) = 0.032$
 From table 5A.1, $TBDY$: $esu1_nominal = 0.08$,
 For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, $TBDY$.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25*(lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = fs = 389.0139$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 466.8167$
 $fy2 = 389.0139$
 $su2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/lb,min = 0.30$
 $su2 = 0.4*esu2_nominal((5.5), TBDY) = 0.032$
 From table 5A.1, $TBDY$: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, $TBDY$.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25*(lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = fs = 389.0139$
 with $Es2 = Es = 200000.00$
 $yv = 0.00140044$
 $shv = 0.0044814$
 $ftv = 466.8167$
 $fyv = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/d = 0.30$
 $suv = 0.4*esuv_nominal((5.5), TBDY) = 0.032$
 From table 5A.1, $TBDY$: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, $TBDY$

For calculation of $\epsilon_{sv_nominal}$ and γ_v , ϕ_v , ϕ_{ftv} , ϕ_{fyv} , it is considered characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.

γ_1 , ϕ_1 , ϕ_{ft1} , ϕ_{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 $f_{sv} = f_s = 389.0139$

with $E_{sv} = E_s = 200000.00$

$1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.05813483$

$2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.05813483$

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.05813483$

and confined core properties:

$b = 340.00$

$d = 228.00$

$d' = 12.00$

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

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

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

$1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.07739312$

$2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.07739312$

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.07739312$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$\mu_u \text{ (4.9)} = 0.19817337$

$\mu_u = M_{Rc} \text{ (4.14)} = 6.6448E+007$

$u = \mu_u \text{ (4.1)} = 2.4749691E-005$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_{u1} -

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

$u = 2.4749691E-005$

$\mu_u = 6.6448E+007$

with full section properties:

$b = 400.00$

$d = 258.00$

$d' = 42.00$

$v = 5.5617499E-005$

$N = 189.411$

$f_c = 33.00$

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

Final value of μ_u : $\mu_u^* = \text{shear_factor} \cdot \text{Max}(\mu_u, cc) = 0.00553582$

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

From (5.4b), TBDY: $\mu_u = 0.00553582$

$\mu_{ue} \text{ (5.4c)} = 0.00259035$

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

$b_o = 240.00$

$h_o = 340.00$

$b_{i2} = 346400.00$

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

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

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

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

No stirrups, $n_s = 2.00$

$b_k = 300.00$

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 = 0.002
 c = confinement factor = 1.00

y1 = 0.00140044
 sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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 = 389.0139

with Es1 = Es = 200000.00

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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 = 389.0139

with Es2 = Es = 200000.00

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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 = 389.0139

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.05813483

2 = Asl,com/(b*d)*(fs2/fc) = 0.05813483

v = Asl,mid/(b*d)*(fsv/fc) = 0.05813483

and confined core properties:

b = 340.00

d = 228.00

d' = 12.00

fcc (5A.2, TBDY) = 33.00

```

cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07739312
2 = Asl,com/(b*d)*(fs2/fc) = 0.07739312
v = Asl,mid/(b*d)*(fsv/fc) = 0.07739312
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19817337
Mu = MRc (4.14) = 6.6448E+007
u = su (4.1) = 2.4749691E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

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

```

u = 2.4749691E-005
Mu = 6.6448E+007

```

with full section properties:

```

b = 400.00
d = 258.00
d' = 42.00
v = 5.5617499E-005
N = 189.411
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00553582
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00553582
we (5.4c) = 0.00259035
ase ((5.4d), TBDY) = 0.15672608
bo = 240.00
ho = 340.00
bi2 = 346400.00
psh,min = Min(psh,x , psh,y) = 0.00261799
Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

```

```

psh,x (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 = 0.002
c = confinement factor = 1.00
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167

```



```

fy1 = 389.0139
su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30
    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 = 389.0139
    with Es1 = Es = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
    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 = 389.0139
    with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30
    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 = 389.0139
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05813483
2 = Asl,com/(b*d)*(fs2/fc) = 0.05813483
v = Asl,mid/(b*d)*(fsv/fc) = 0.05813483
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07739312
2 = Asl,com/(b*d)*(fs2/fc) = 0.07739312
v = Asl,mid/(b*d)*(fsv/fc) = 0.07739312
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19817337
Mu = MRc (4.14) = 6.6448E+007
u = su (4.1) = 2.4749691E-005

```

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_2 -

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

$$\mu = 2.4749691E-005$$

$$\mu_2 = 6.6448E+007$$

with full section properties:

$$b = 400.00$$

$$d = 258.00$$

$$d' = 42.00$$

$$v = 5.5617499E-005$$

$$N = 189.411$$

$$f_c = 33.00$$

$$\omega_0 (5A.5, \text{TB DY}) = 0.002$$

$$\text{Final value of } \mu_2: \mu_2^* = \text{shear_factor} * \text{Max}(\mu_2, \mu_0) = 0.00553582$$

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

$$\text{From (5.4b), TB DY: } \mu_2 = 0.00553582$$

$$\omega_0 (5.4c) = 0.00259035$$

$$\omega_0 (5.4d), \text{ TB DY} = 0.15672608$$

$$b_0 = 240.00$$

$$h_0 = 340.00$$

$$b_i^2 = 346400.00$$

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

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

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

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

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

$$b_k = 300.00$$

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

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

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A.5), TB DY), TB DY: } \mu_0 = 0.002$$

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

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

$$l_0/l_{ou,min} = l_b/l_d = 0.30$$

$$su_1 = 0.4 * su_{1,nominal} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } su_{1,nominal} = 0.08,$$

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

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

$$\text{with } fs_1 = fs = 389.0139$$

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

```

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
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 = 389.0139
with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.30
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 = 389.0139
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05813483
2 = Asl,com/(b*d)*(fs2/fc) = 0.05813483
v = Asl,mid/(b*d)*(fsv/fc) = 0.05813483
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07739312
2 = Asl,com/(b*d)*(fs2/fc) = 0.07739312
v = Asl,mid/(b*d)*(fsv/fc) = 0.07739312
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19817337
Mu = MRc (4.14) = 6.6448E+007
u = su (4.1) = 2.4749691E-005

```

Calculation of ratio lb/lb

Inadequate Lap Length with lb/lb = 0.30

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

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

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: $V_c = 88236.482$

= 1 (normal-weight concrete)

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

$\rho_w = A_s/(b_w*d) = 0.00628319$

A_s (tension reinf.) = 603.1858

$b_w = 400.00$

$d = 240.00$

$V_u*d/M_u < 1 = 0.00$

$M_u = 3.4215184E-013$

$V_u = 8.6414578E-021$

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) '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: $V_c = 88236.482$

= 1 (normal-weight concrete)

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

$\rho_w = A_s/(b_w*d) = 0.00628319$

A_s (tension reinf.) = 603.1858

$b_w = 400.00$

$d = 240.00$

$V_u*d/M_u < 1 = 0.00$

$M_u = 3.4215797E-013$

$V_u = 8.6414578E-021$

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, $\phi = 0.90$

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

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$
 Steel Elasticity, $E_s = 200000.00$
 Section Height, $H = 400.00$
 Section Width, $W = 300.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 1850.00$
 Primary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Inadequate Lap Length with $l_b/l_d = 0.30$
 No FRP Wrapping

Stepwise Properties

Bending Moment, $M = -7.2037543E-011$
 Shear Force, $V_2 = -2.9102230E-014$
 Shear Force, $V_3 = -2011.333$
 Axial Force, $F = -459.9979$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{st} = 603.1858$
 -Compression: $A_{sc} = 923.6282$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{st,ten} = 508.938$
 -Compression: $A_{st,com} = 508.938$
 -Middle: $A_{st,mid} = 508.938$
 Mean Diameter of Tension Reinforcement, $D_bL = 14.66667$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.00706586$
 $u = y + p = 0.00706586$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00206586$ ((4.29), Biskinis Phd))
 $M_y = 4.8843E+007$
 $L_s = M/V$ (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 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 8.1950237E-006$
 with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b/l_d)^{2/3}) = 311.2112$
 $d = 258.00$
 $y = 0.26403826$
 $A = 0.01480903$
 $B = 0.0086159$
 with $p_t = 0.00493157$
 $p_c = 0.00493157$
 $p_v = 0.00493157$
 $N = 459.9979$
 $b = 400.00$
 $" = 0.1627907$
 $y_{comp} = 3.2314820E-005$
 with $f_c = 33.00$
 $E_c = 26999.444$
 $y = 0.26388224$

A = 0.01478458
B = 0.00860158
with Es = 200000.00

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

- 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 $V_p/V_o = 0.37228966$

- Transverse Reinforcement: NC

- Stirrup Spacing $> d/3$

- Low ductility demand, $\lambda / y < 2$ (table 10-6, ASCE 41-17)
 $= -4.0323671E-022$

- 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 = $2.9102230E-014$

- ($\lambda - y$)/ bal = -0.18222013

$= A_{st}/(b_w \times d) = 0.00584482$

Tension Reinf Area: $A_{st} = 603.1858$

$\lambda = A_{sc}/(b_w \times d) = 0.00894989$

Compression Reinf Area: $A_{sc} = 923.6282$

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): $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + y) = 0.51922877$
 $y = 0.0027778$

- $V/(b_w \times d \times f_c^{0.5}) = 5.9117060E-019$, 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

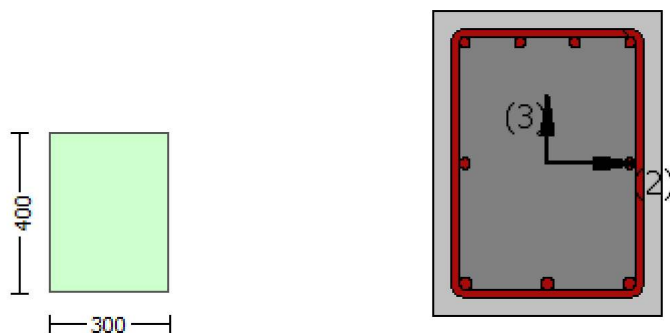
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (2)



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

At local axis: 2

Integration Section: (b)

Section Type: rcars

Constant Properties

Knowledge Factor, $\gamma = 0.90$

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

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 1850.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{o,min} = l_b/l_d = 0.30$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = -7.2037543E-011$

Shear Force, $V_a = -2.9102230E-014$

EDGE -B-

Bending Moment, $M_b = 1.8189791E-011$

Shear Force, $V_b = 2.9102230E-014$

BOTH EDGES

Axial Force, $F = -459.9979$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 615.7522$
 -Compression: $As_c = 911.0619$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 508.938$
 -Compression: $As_{c,com} = 508.938$
 -Middle: $As_{mid} = 508.938$
 Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 14.66667$

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

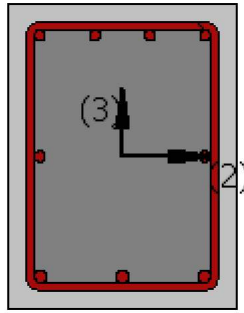
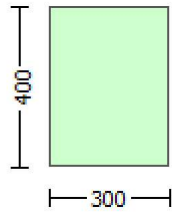
NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

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)
 $\rho_w = As/(b_w \cdot d) = 0.00641409$
 As (tension reinf.) = 615.7522
 $b_w = 400.00$
 $d = 240.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 1.8189791E-011$
 $V_u = 2.9102230E-014$
 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: Immediate Occupancy (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, $\gamma = 0.90$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

#####

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 = 1.00

Element Length, $L = 1850.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{ou,min} = 0.30$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 2740.264$

EDGE -B-

Shear Force, $V_b = 2740.264$

BOTH EDGES

Axial Force, $F = -189.411$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_{lt} = 603.1858$

-Compression: $As_{lc} = 923.6282$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{l,ten} = 603.1858$

-Compression: $As_{l,com} = 615.7522$

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

Calculation of Shear Capacity ratio , $V_e/V_r = 0.39580698$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 112670.646$
 with
 $M_{pr1} = \text{Max}(\mu_{1+}, \mu_{1-}) = 1.0175\text{E}+008$
 $\mu_{1+} = 9.9812\text{E}+007$, 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
 $\mu_{1-} = 1.0175\text{E}+008$, 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
 $M_{pr2} = \text{Max}(\mu_{2+}, \mu_{2-}) = 1.0162\text{E}+008$
 $\mu_{2+} = 9.9934\text{E}+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
 which is defined for the the static loading combination
 $\mu_{2-} = 1.0162\text{E}+008$, 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
 $V_1 = 2740.264$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 2740.264$, 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:

$$\mu = 1.7580246\text{E}-005$$

$$\mu_u = 9.9812\text{E}+007$$

 with full section properties:

$$b = 300.00$$

$$d = 357.00$$

$$d' = 42.00$$

$$v = 5.3592212\text{E}-005$$

$$N = 189.411$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu_u: \mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.00553582$$

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

$$\text{From (5.4b), TB DY: } \mu_u = 0.00553582$$

$$\mu_w(5.4c) = 0.00259035$$

$$\mu_{ase}((5.4d), \text{TB DY}) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

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

Expression ((5.4d), TB DY) for $\mu_{psh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without
 earthquake detailing (90° closed stirrups)

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

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

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

$$b_k = 300.00$$

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

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

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

$$b_k = 400.00$$

 $s = 150.00$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

```

ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
    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 = 389.0139
    with Es1 = Es = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
    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 = 389.0139
    with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
    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 = 389.0139
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06639156
2 = Asl,com/(b*d)*(fs2/fc) = 0.06777471
v = Asl,mid/(b*d)*(fsv/fc) = 0.03388736
and confined core properties:
b = 240.00
d = 327.00
d' = 12.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.09060316
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09249072
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04624536
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18421297
Mu = MRc (4.14) = 9.9812E+007

```

$$u = su(4.1) = 1.7580246E-005$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_{u1} -

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

$$\mu_u = 1.7569691E-005$$

$$\mu_u = 1.0175E+008$$

with full section properties:

$$b = 300.00$$

$$d = 358.00$$

$$d' = 43.00$$

$$v = 5.3442513E-005$$

$$N = 189.411$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu_{cu}: \mu_{cu}^* = \text{shear_factor} * \text{Max}(\mu_{cu}, \mu_{cc}) = 0.00553582$$

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

$$\text{From (5.4b), TB DY: } \mu_{cu} = 0.00553582$$

$$\mu_{we}(5.4c) = 0.00259035$$

$$\mu_{ase}((5.4d), \text{TB DY}) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

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

Expression ((5.4d), TB DY) for $\mu_{psh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

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

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

$$b_k = 300.00$$

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

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

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

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

$$l_o/l_{ou,min} = l_b/l_d = 0.30$$

$$su_1 = 0.4 * su_{1,nominal}((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } su_{1,nominal} = 0.08,$$

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

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

$$\text{with } fs_1 = fs = 389.0139$$

```

with Es1 = Es = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
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 = 389.0139
with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30
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 = 389.0139
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0675854
2 = Asl,com/(b*d)*(fs2/fc) = 0.06620611
v = Asl,mid/(b*d)*(fsv/fc) = 0.0337927
and confined core properties:
b = 240.00
d = 328.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09220874
2 = Asl,com/(b*d)*(fs2/fc) = 0.09032693
v = Asl,mid/(b*d)*(fsv/fc) = 0.04610437
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18600297
Mu = MRc (4.14) = 1.0175E+008
u = su (4.1) = 1.7569691E-005

```

Calculation of ratio lb/d

Inadequate Lap Length with lb/d = 0.30

Calculation of Mu2+

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

$$\phi_u = 1.7539903E-005$$

$$\mu_u = 9.9934E+007$$

with full section properties:

$$b = 300.00$$

$$d = 358.00$$

$$d' = 43.00$$

$$v = 5.3442513E-005$$

$$N = 189.411$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00553582$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00553582$$

$$\phi_{we} (5.4c) = 0.00259035$$

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

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_i^2 = 346400.00$$

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

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

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

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

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

$$b_k = 300.00$$

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

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

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$f_{t1} = 466.8167$$

$$f_{y1} = 389.0139$$

$$su_1 = 0.00512$$

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

$$l_o/l_{ou,min} = l_b/l_d = 0.30$$

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

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

For calculation of $\phi_{su1_nominal}$ and y_1 , sh_1 , f_{t1} , f_{y1} , it is considered
characteristic value $f_{sy1} = f_{s1}/1.2$, from table 5.1, TBDY.

$$y_1, sh_1, f_{t1}, f_{y1}, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b/l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } f_{s1} = f_s = 389.0139$$

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

$$y_2 = 0.00140044$$

$$sh_2 = 0.0044814$$

$$f_{t2} = 466.8167$$

$$f_{y2} = 389.0139$$

$$su_2 = 0.00512$$

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

$$l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$$

$$su_2 = 0.4 * \phi_{su2_nominal} ((5.5), \text{TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } \phi_{su2_nominal} = 0.08,$$

For calculation of $\phi_{su2_nominal}$ 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 $f_{s2} = f_s = 389.0139$
 with $E_{s2} = E_s = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 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 $f_{sv} = f_s = 389.0139$
 with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.06620611$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.0675854$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.0337927$
 and confined core properties:
 $b = 240.00$
 $d = 328.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.09032693$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.09220874$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.04610437$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.18462058$
 $Mu = MR_c (4.14) = 9.9934E+007$
 $u = su (4.1) = 1.7539903E-005$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of $Mu2$ -

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

$u = 1.7610316E-005$
 $Mu = 1.0162E+008$

with full section properties:

$b = 300.00$
 $d = 357.00$
 $d' = 42.00$
 $v = 5.3592212E-005$
 $N = 189.411$
 $f_c = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, cc) = 0.00553582$

The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.00553582$
 w_e (5.4c) = 0.00259035
 a_{se} ((5.4d), TBDY) = 0.15672608
 $b_o = 240.00$
 $h_o = 340.00$
 $b_{i2} = 346400.00$
 $p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00261799$
 Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $p_{sh,x}$ (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: $c_c = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y_1 = 0.00140044$
 $sh_1 = 0.0044814$
 $ft_1 = 466.8167$
 $fy_1 = 389.0139$
 $su_1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $su_1 = 0.4 * esu1_{nominal}$ ((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 $fs_1 = fs = 389.0139$
 with $Es_1 = Es = 200000.00$
 $y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 466.8167$
 $fy_2 = 389.0139$
 $su_2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$
 $su_2 = 0.4 * esu2_{nominal}$ ((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 $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 389.0139$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $su_v = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$

$suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$
 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 $fsv = fs = 389.0139$
 with $Esv = Es = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.06777471$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.06639156$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.03388736$
 and confined core properties:
 $b = 240.00$
 $d = 327.00$
 $d' = 12.00$
 $fcc (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.09249072$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.09060316$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.04624536$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied
 ---->
 $su (4.9) = 0.18560594$
 $Mu = MRc (4.14) = 1.0162E+008$
 $u = su (4.1) = 1.7610316E-005$

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Shear Strength $Vr = Min(Vr1, Vr2) = 284660.584$

Calculation of Shear Strength at edge 1, $Vr1 = 284660.584$
 $Vr1 = Vn ((22.5.1.1), ACI 318-14)$

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: $Vc = 98490.641$
 $= 1$ (normal-weight concrete)
 $fc' = 33.00$, but $fc^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $pw = As/(bw*d) = 0.00628319$
 As (tension reinf.) = 603.1858
 $bw = 300.00$
 $d = 320.00$
 $Vu*d/Mu < 1 = 1.00$
 $Mu = 69262.055$
 $Vu = 2740.264$

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, $Vr2 = 284660.584$
 $Vr2 = Vn ((22.5.1.1), ACI 318-14)$

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

From Table (22.5.5.1), ACI 318-14: $V_c = 98490.641$
= 1 (normal-weight concrete)

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

$\rho_w = A_s/(b_w*d) = 0.00628319$

A_s (tension reinf.) = 603.1858

$b_w = 300.00$

$d = 320.00$

$V_u*d/M_u < 1 = 1.00$

$M_u = 69262.055$

$V_u = 2740.264$

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, $\lambda = 0.90$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

#####

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 = 1.00

Element Length, $L = 1850.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{ou,min} = 0.30$

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = -8.6414578E-021$

EDGE -B-

Shear Force, $V_b = 8.6414578E-021$

BOTH EDGES

Axial Force, $F = -189.411$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 603.1858$

-Compression: $As_c = 923.6282$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 508.938$

-Compression: $As_{c,com} = 508.938$

-Middle: $As_{mid} = 508.938$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.37228966$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 71835.924$ with

$M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 6.6448E+007$

$Mu_{1+} = 6.6448E+007$, 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

$Mu_{1-} = 6.6448E+007$, 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

$M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 6.6448E+007$

$Mu_{2+} = 6.6448E+007$, 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

$Mu_{2-} = 6.6448E+007$, 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

$V_1 = -8.6414578E-021$, is the shear force acting at edge 1 for the static loading combination

$V_2 = 8.6414578E-021$, 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:

$\phi_u = 2.4749691E-005$

$M_u = 6.6448E+007$

with full section properties:

$b = 400.00$

$d = 258.00$

$d' = 42.00$

$v = 5.5617499E-005$

$N = 189.411$

$f_c = 33.00$

ϕ_c (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00553582$

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

From (5.4b), TBDY: $\phi_u = 0.00553582$

w_e (5.4c) = 0.00259035

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

$b_o = 240.00$

$h_o = 340.00$

$bi_2 = 346400.00$

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

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

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

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

No stirrups, $n_s = 2.00$

$b_k = 300.00$

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 = 0.002
c = confinement factor = 1.00

y1 = 0.00140044
sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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 = 389.0139

with Es1 = Es = 200000.00

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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 = 389.0139

with Es2 = Es = 200000.00

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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 = 389.0139

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.05813483

2 = Asl,com/(b*d)*(fs2/fc) = 0.05813483

v = Asl,mid/(b*d)*(fsv/fc) = 0.05813483

and confined core properties:

b = 340.00

d = 228.00

d' = 12.00

fcc (5A.2, TBDY) = 33.00

```

cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07739312
2 = Asl,com/(b*d)*(fs2/fc) = 0.07739312
v = Asl,mid/(b*d)*(fsv/fc) = 0.07739312
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19817337
Mu = MRc (4.14) = 6.6448E+007
u = su (4.1) = 2.4749691E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

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

```

u = 2.4749691E-005
Mu = 6.6448E+007

```

with full section properties:

```

b = 400.00
d = 258.00
d' = 42.00
v = 5.5617499E-005
N = 189.411
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00553582
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00553582
we (5.4c) = 0.00259035
ase ((5.4d), TBDY) = 0.15672608
bo = 240.00
ho = 340.00
bi2 = 346400.00
psh,min = Min(psh,x , psh,y) = 0.00261799

```

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

```

psh,x (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 = 0.002
c = confinement factor = 1.00
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167

```

```

fy1 = 389.0139
su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 0.30
    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 = 389.0139
    with Es1 = Es = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
    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 = 389.0139
    with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 0.30
    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 = 389.0139
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05813483
2 = Asl,com/(b*d)*(fs2/fc) = 0.05813483
v = Asl,mid/(b*d)*(fsv/fc) = 0.05813483
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07739312
2 = Asl,com/(b*d)*(fs2/fc) = 0.07739312
v = Asl,mid/(b*d)*(fsv/fc) = 0.07739312
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19817337
Mu = MRc (4.14) = 6.6448E+007
u = su (4.1) = 2.4749691E-005

```

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_{2+}

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

$$\mu = 2.4749691E-005$$

$$\mu = 6.6448E+007$$

with full section properties:

$$b = 400.00$$

$$d = 258.00$$

$$d' = 42.00$$

$$v = 5.5617499E-005$$

$$N = 189.411$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu, \alpha) = 0.00553582$$

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

$$\text{From (5.4b), TB DY: } \mu = 0.00553582$$

$$\mu (5.4c) = 0.00259035$$

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

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_i^2 = 346400.00$$

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

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

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

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

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

$$b_k = 300.00$$

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

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

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

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

$$l_o/l_{o,\text{min}} = l_b/l_d = 0.30$$

$$su_1 = 0.4 * su_{1,\text{nominal}} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } su_{1,\text{nominal}} = 0.08,$$

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

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

$$\text{with } fs_1 = fs = 389.0139$$

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

```

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
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 = 389.0139
with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.30
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 = 389.0139
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05813483
2 = Asl,com/(b*d)*(fs2/fc) = 0.05813483
v = Asl,mid/(b*d)*(fsv/fc) = 0.05813483
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07739312
2 = Asl,com/(b*d)*(fs2/fc) = 0.07739312
v = Asl,mid/(b*d)*(fsv/fc) = 0.07739312
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19817337
Mu = MRc (4.14) = 6.6448E+007
u = su (4.1) = 2.4749691E-005

```

Calculation of ratio lb/lb

Inadequate Lap Length with lb/lb = 0.30

Calculation of Mu2-

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

u = 2.4749691E-005
Mu = 6.6448E+007

with full section properties:

b = 400.00
d = 258.00
d' = 42.00
v = 5.5617499E-005
N = 189.411

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu: $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00553582$

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

From (5.4b), TBDY: $cu = 0.00553582$

we (5.4c) = 0.00259035

ase ((5.4d), TBDY) = 0.15672608

bo = 240.00

ho = 340.00

bi2 = 346400.00

psh,min = Min(psh,x , psh,y) = 0.00261799

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

psh,x (5.4d) = 0.00349066

Ash = Astir*ns = 78.53982

No stirrups, ns = 2.00

bk = 300.00

psh,y (5.4d) = 0.00261799

Ash = Astir*ns = 78.53982

No stirrups, ns = 2.00

bk = 400.00

s = 150.00

fywe = 694.45

fce = 33.00

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

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30

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

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

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

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

with $fs1 = fs = 389.0139$

with $Es1 = Es = 200000.00$

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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

From table 5A.1, TBDY: $\text{esu2_nominal} = 0.08$,

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 $fs2 = fs = 389.0139$
 with $Es2 = Es = 200000.00$
 $yv = 0.00140044$
 $shv = 0.0044814$
 $ftv = 466.8167$
 $fyv = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou, min = lb/ld = 0.30$
 $suv = 0.4 \cdot esuv_nominal \cdot ((5.5), TBDY) = 0.032$
 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 $fsv = fs = 389.0139$
 with $Es = Es = 200000.00$
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.05813483$
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.05813483$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.05813483$
 and confined core properties:

$b = 340.00$
 $d = 228.00$
 $d' = 12.00$
 $fcc \text{ (5A.2, TBDY)} = 33.00$
 $cc \text{ (5A.5, TBDY)} = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.07739312$
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.07739312$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.07739312$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

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

$su \text{ (4.9)} = 0.19817337$
 $Mu = MRc \text{ (4.14)} = 6.6448E+007$
 $u = su \text{ (4.1)} = 2.4749691E-005$

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Shear Strength $Vr = \text{Min}(Vr1, Vr2) = 192957.075$

Calculation of Shear Strength at edge 1, $Vr1 = 192957.075$
 $Vr1 = Vn \text{ ((22.5.1.1), ACI 318-14)}$

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 $fc'^{0.5} \leq 8.3 \text{ MPa}$ (22.5.3.1, ACI 318-14)
 $pw = As / (bw \cdot d) = 0.00628319$
 $As \text{ (tension reinf.)} = 603.1858$
 $bw = 400.00$
 $d = 240.00$
 $Vu \cdot d / Mu < 1 = 0.00$
 $Mu = 3.4215184E-013$

$$V_u = 8.6414578E-021$$

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)

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

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

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

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)

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

$$p_w = A_s / (b_w \cdot d) = 0.00628319$$

$$A_s (\text{tension reinf.}) = 603.1858$$

$$b_w = 400.00$$

$$d = 240.00$$

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

$$M_u = 3.4215797E-013$$

$$V_u = 8.6414578E-021$$

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: (b)

Section Type: rcars

Constant Properties

Knowledge Factor, $\phi = 0.90$

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

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 1850.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_b / l_d = 0.30$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 4.4091\text{E}+006$

Shear Force, $V2 = 2.9102230\text{E}-014$

Shear Force, $V3 = 7491.862$

Axial Force, $F = -459.9979$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 615.7522$

-Compression: $As_c = 911.0619$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 615.7522$

-Compression: $As_{c,com} = 603.1858$

-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 $u_R = 1.0^*$ $u = 0.00609076$

$u = y + p = 0.00609076$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00109076$ ((4.29), Biskinis Phd))

$M_y = 7.2059\text{E}+007$

$L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 588.5156

From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 1.2960\text{E}+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

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

$y_{ten} = 5.8357660\text{E}-006$

with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (I_b / I_d)^{2/3}) = 311.2112$

$d = 358.00$

$y = 0.25519213$

$A = 0.01422991$

$B = 0.00802707$

with $p_t = 0.00573326$

$p_c = 0.00561626$

$p_v = 0.00286663$

$N = 459.9979$

$b = 300.00$

$" = 0.12011173$

$y_{comp} = 2.4096452\text{E}-005$

with $f_c = 33.00$

$E_c = 26999.444$

$y = 0.25503248$

$A = 0.01420641$

$B = 0.00801331$

with $E_s = 200000.00$

Calculation of ratio I_b / I_d

Inadequate Lap Length with $I_b / I_d = 0.30$

- 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 $V_p/V_o = 0.39580698$
- Transverse Reinforcement: NC
- Stirrup Spacing $> d/3$
- Low ductility demand, $\lambda / y < 2$ (table 10-6, ASCE 41-17)
 $= 1.1318832E-005$
- 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 = 7491.862
- ($\lambda - \lambda'$)/ bal = -0.16136132
 $= A_{sl}/(b_w \times d) = 0.00573326$
Tension Reinf Area: $A_{sl} = 615.7522$
 $\lambda' = A_{slc}/(b_w \times d) = 0.00848289$
Compression Reinf Area: $A_{slc} = 911.0619$
- 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): $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + y) = 0.51922877$
 $y = 0.0027778$
- $V/(b_w \times d \times f_c^{0.5}) = 0.14623514$, 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. 7

beam B1, Floor 1

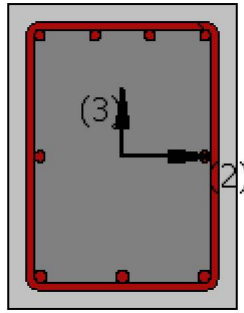
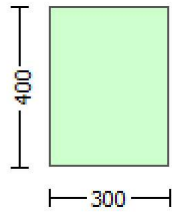
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (3)



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

At local axis: 3

Integration Section: (b)

Section Type: rcars

Constant Properties

Knowledge Factor, $\phi = 0.90$

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

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 1850.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{o,min} = l_b/l_d = 0.30$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 4.3814E+006$

Shear Force, $V_a = -2011.333$

EDGE -B-

Bending Moment, $M_b = 4.4091E+006$

Shear Force, $V_b = 7491.862$

BOTH EDGES

Axial Force, $F = -459.9979$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 615.7522$

-Compression: $As_c = 911.0619$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 615.7522$

-Compression: $As_{c,com} = 603.1858$

-Middle: $As_{mid} = 307.8761$

Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 14.00$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $VR = 1.0 \cdot V_n = 250043.372$

V_n ((22.5.1.1), ACI 318-14) = 250043.372

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: $V_c = 82491.763$

= 1 (normal-weight concrete)

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

$\rho_w = A_s / (b_w * d) = 0.00641409$

A_s (tension reinf.) = 615.7522

$b_w = 300.00$

$d = 320.00$

$V_u * d / M_u < 1 = 0.54374086$

$M_u = 4.4091E+006$

$V_u = 7491.862$

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 ($s \leq d/2$, according to ASCE 41-17, 10.3.4)

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

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

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

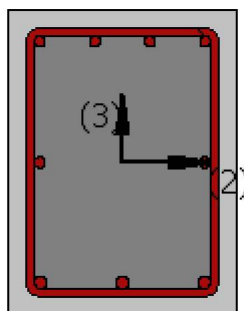
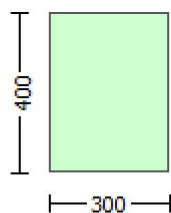
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (μ)

Edge: End

Local Axis: (3)



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

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcars

Constant Properties

Knowledge Factor, $\phi = 0.90$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

#####

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 = 1.00

Element Length, $L = 1850.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{ou,min} = 0.30$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 2740.264$

EDGE -B-

Shear Force, $V_b = 2740.264$

BOTH EDGES

Axial Force, $F = -189.411$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{sl,t} = 603.1858$

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

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten} = 603.1858$

-Compression: $A_{sl,com} = 615.7522$

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

Calculation of Shear Capacity ratio, $V_e/V_r = 0.39580698$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 112670.646$

with
 $M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 1.0175E+008$
 $M_{u1+} = 9.9812E+007$, 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

$M_{u1-} = 1.0175E+008$, 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

$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 1.0162E+008$

$M_{u2+} = 9.9934E+007$, 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

$M_{u2-} = 1.0162E+008$, 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 = 2740.264, is the shear force acting at edge 1 for the the static loading combination
V2 = 2740.264, 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:

$$\phi_u = 1.7580246E-005$$

$$M_u = 9.9812E+007$$

with full section properties:

$$b = 300.00$$

$$d = 357.00$$

$$d' = 42.00$$

$$\nu = 5.3592212E-005$$

$$N = 189.411$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{co}) = 0.00553582$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00553582$$

$$\phi_{we} (5.4c) = 0.00259035$$

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

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

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

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

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

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

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

$$b_k = 300.00$$

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

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

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$f_{t1} = 466.8167$$

$$f_{y1} = 389.0139$$

$$s_{u1} = 0.00512$$

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

$$l_o/l_{ou,min} = l_b/l_d = 0.30$$

$$s_{u1} = 0.4 * s_{u1,nominal} ((5.5), TBDY) = 0.032$$

$$\text{From table 5A.1, TBDY: } s_{u1,nominal} = 0.08,$$

For calculation of $s_{u1,nominal}$ 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.

$$\text{with } f_{s1} = f_s = 389.0139$$

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

$$y_2 = 0.00140044$$

$$sh_2 = 0.0044814$$

$$f_{t2} = 466.8167$$

$$f_{y2} = 389.0139$$

```

su2 = 0.00512
using (30) in Biskinis/Fardis (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 = 0.30
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 = 389.0139
with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (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 = 0.30
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 = 389.0139
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06639156
2 = Asl,com/(b*d)*(fs2/fc) = 0.06777471
v = Asl,mid/(b*d)*(fsv/fc) = 0.03388736
and confined core properties:
b = 240.00
d = 327.00
d' = 12.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09060316
2 = Asl,com/(b*d)*(fs2/fc) = 0.09249072
v = Asl,mid/(b*d)*(fsv/fc) = 0.04624536
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18421297
Mu = MRc (4.14) = 9.9812E+007
u = su (4.1) = 1.7580246E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

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

u = 1.7569691E-005

Mu = 1.0175E+008

with full section properties:

$b = 300.00$
 $d = 358.00$
 $d' = 43.00$
 $v = 5.3442513E-005$
 $N = 189.411$
 $f_c = 33.00$
 $\phi (5A.5, TBDY) = 0.002$
 Final value of ϕ : $\phi^* = \text{shear_factor} * \text{Max}(\phi_c, \phi_s) = 0.00553582$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\phi_c = 0.00553582$
 $\phi_s (5.4c) = 0.00259035$
 $\phi_{se} ((5.4d), TBDY) = 0.15672608$
 $\phi_{bo} = 240.00$
 $\phi_{ho} = 340.00$
 $\phi_{bi2} = 346400.00$
 $\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00261799$
 Expression ((5.4d), TBDY) for $\phi_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$\phi_{sh,x} (5.4d) = 0.00349066$
 $A_{sh} = A_{stir} * n_s = 78.53982$
 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 ((5A5), TBDY), TBDY: $\phi_c = 0.002$
 $\phi_c = \text{confinement factor} = 1.00$
 $y_1 = 0.00140044$
 $sh_1 = 0.0044814$
 $ft_1 = 466.8167$
 $fy_1 = 389.0139$
 $su_1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $su_1 = 0.4 * \phi_{su1_nominal} ((5.5), TBDY) = 0.032$
 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 $\phi_{sy1} = \phi_{s1}/1.2$, 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 $\phi_{s1} = \phi_s = 389.0139$
 with $E_{s1} = E_s = 200000.00$
 $y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 466.8167$
 $fy_2 = 389.0139$
 $su_2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$
 $su_2 = 0.4 * \phi_{su2_nominal} ((5.5), TBDY) = 0.032$
 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 $\phi_{sy2} = \phi_{s2}/1.2$, 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 $\phi_{s2} = \phi_s = 389.0139$
 with $E_{s2} = E_s = 200000.00$
 $y_v = 0.00140044$

```

shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (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 = 0.30
    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 = 389.0139
    with Esv = Es = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.0675854
    2 = Asl,com/(b*d)*(fs2/fc) = 0.06620611
    v = Asl,mid/(b*d)*(fsv/fc) = 0.0337927
and confined core properties:
b = 240.00
d = 328.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.09220874
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09032693
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04610437
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18600297
Mu = MRc (4.14) = 1.0175E+008
u = su (4.1) = 1.7569691E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

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

```

u = 1.7539903E-005
Mu = 9.9934E+007

```

with full section properties:

```

b = 300.00
d = 358.00
d' = 43.00
v = 5.3442513E-005
N = 189.411
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00553582
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00553582
we (5.4c) = 0.00259035
ase ((5.4d), TBDY) = 0.15672608
bo = 240.00

```

$h_o = 340.00$
 $bi2 = 346400.00$
 $psh,min = \text{Min}(psh,x, psh,y) = 0.00261799$
 Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

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

$s = 150.00$
 $fywe = 694.45$
 $fce = 33.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 466.8167$
 $fy1 = 389.0139$
 $su1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/ld = 0.30$
 $su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu1_nominal = 0.08$,
 For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs/1.2$, 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 $fs1 = fs = 389.0139$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 466.8167$
 $fy2 = 389.0139$
 $su2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/lb,min = 0.30$
 $su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs/1.2$, 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 $fs2 = fs = 389.0139$
 with $Es2 = Es = 200000.00$
 $yv = 0.00140044$
 $shv = 0.0044814$
 $ftv = 466.8167$
 $fyv = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/ld = 0.30$
 $suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032$
 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 $fsv = fs = 389.0139$
 with $Esv = Es = 200000.00$
 $1 = Asl,ten/(b \cdot d) \cdot (fs1/fc) = 0.06620611$
 $2 = Asl,com/(b \cdot d) \cdot (fs2/fc) = 0.0675854$
 $v = Asl,mid/(b \cdot d) \cdot (fsv/fc) = 0.0337927$
 and confined core properties:
 $b = 240.00$
 $d = 328.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl,ten/(b \cdot d) \cdot (fs1/fc) = 0.09032693$
 $2 = Asl,com/(b \cdot d) \cdot (fs2/fc) = 0.09220874$
 $v = Asl,mid/(b \cdot d) \cdot (fsv/fc) = 0.04610437$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.18462058$
 $Mu = MRc (4.14) = 9.9934E+007$
 $u = su (4.1) = 1.7539903E-005$

 Calculation of ratio lb/d

 Inadequate Lap Length with $lb/d = 0.30$

 Calculation of $Mu2$ -

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.7610316E-005$
 $Mu = 1.0162E+008$

 with full section properties:
 $b = 300.00$
 $d = 357.00$
 $d' = 42.00$
 $v = 5.3592212E-005$
 $N = 189.411$
 $fc = 33.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.00553582$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.00553582$
 $we (5.4c) = 0.00259035$
 $ase ((5.4d), TBDY) = 0.15672608$
 $bo = 240.00$
 $ho = 340.00$
 $bi2 = 346400.00$
 $psh,min = \text{Min}(psh,x, psh,y) = 0.00261799$
 Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without
 earthquake detailing (90° closed stirrups)

 $psh,x (5.4d) = 0.00349066$
 $Ash = Astir \cdot ns = 78.53982$
 No stirrups, $ns = 2.00$
 $bk = 300.00$

 $psh,y (5.4d) = 0.00261799$
 $Ash = Astir \cdot ns = 78.53982$

No stirrups, ns = 2.00
bk = 400.00

s = 150.00
fywe = 694.45
fce = 33.00

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

y1 = 0.00140044
sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

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

lo/lou,min = lb/lb = 0.30

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 = 389.0139

with Es1 = Es = 200000.00

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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 = 389.0139

with Es2 = Es = 200000.00

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

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

lo/lou,min = lb/lb = 0.30

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 = 389.0139

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.06777471

2 = Asl,com/(b*d)*(fs2/fc) = 0.06639156

v = Asl,mid/(b*d)*(fsv/fc) = 0.03388736

and confined core properties:

b = 240.00

d = 327.00

d' = 12.00

fcc (5A.2, TBDY) = 33.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.09249072$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.09060316$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.04624536$$

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

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

--->
 $\mu_u(4.9) = 0.18560594$
 $\mu_u = M_{Rc}(4.14) = 1.0162E+008$
 $u = \mu_u(4.1) = 1.7610316E-005$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 284660.584$

Calculation of Shear Strength at edge 1, $V_{r1} = 284660.584$
 $V_{r1} = V_n((22.5.1.1), \text{ACI 318-14})$

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

From Table (22.5.5.1), ACI 318-14: $V_c = 98490.641$
 $= 1$ (normal-weight concrete)
 $f'_c = 33.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s/(b_w*d) = 0.00628319$
 A_s (tension reinf.) = 603.1858
 $b_w = 300.00$
 $d = 320.00$
 $V_u*d/\mu_u < 1 = 1.00$
 $\mu_u = 69262.055$
 $V_u = 2740.264$

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, $V_{r2} = 284660.584$
 $V_{r2} = V_n((22.5.1.1), \text{ACI 318-14})$

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: $V_c = 98490.641$
 $= 1$ (normal-weight concrete)
 $f'_c = 33.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s/(b_w*d) = 0.00628319$
 A_s (tension reinf.) = 603.1858
 $b_w = 300.00$
 $d = 320.00$
 $V_u*d/\mu_u < 1 = 1.00$
 $\mu_u = 69262.055$
 $V_u = 2740.264$

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)

Vf ((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, $\phi = 0.90$
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$

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 = 1.00
Element Length, $L = 1850.00$
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with $l_o/l_{o,min} = 0.30$
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = -8.6414578E-021$
EDGE -B-
Shear Force, $V_b = 8.6414578E-021$
BOTH EDGES
Axial Force, $F = -189.411$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 603.1858$
-Compression: $A_{sc} = 923.6282$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten} = 508.938$
-Compression: $A_{st,com} = 508.938$
-Middle: $A_{st,mid} = 508.938$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.37228966$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 71835.924$
with
 $M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 6.6448E+007$

Mu1+ = 6.6448E+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

Mu1- = 6.6448E+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

Mpr2 = Max(Mu2+ , Mu2-) = 6.6448E+007

Mu2+ = 6.6448E+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

Mu2- = 6.6448E+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

$\pm v_u \cdot l_n = (|V1| + |V2|)/2$

with

V1 = -8.6414578E-021, is the shear force acting at edge 1 for the the static loading combination

V2 = 8.6414578E-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:

$\phi_u = 2.4749691E-005$

$M_u = 6.6448E+007$

with full section properties:

b = 400.00

d = 258.00

d' = 42.00

$v = 5.5617499E-005$

N = 189.411

$f_c = 33.00$

ϕ_c (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.00553582$

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

From (5.4b), TBDY: $\phi_u = 0.00553582$

ϕ_{ue} (5.4c) = 0.00259035

ϕ_{ase} ((5.4d), TBDY) = 0.15672608

$b_o = 240.00$

$h_o = 340.00$

$b_i^2 = 346400.00$

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

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

 $\phi_{sh,x}$ (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), TBDY), TBDY: $\phi_c = 0.002$

c = confinement factor = 1.00

$y_1 = 0.00140044$

$sh_1 = 0.0044814$

$ft_1 = 466.8167$

$fy_1 = 389.0139$

$su_1 = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30
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 = 389.0139
with Es1 = Es = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
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 = 389.0139
with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30
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 = 389.0139
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05813483
2 = Asl,com/(b*d)*(fs2/fc) = 0.05813483
v = Asl,mid/(b*d)*(fsv/fc) = 0.05813483
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07739312
2 = Asl,com/(b*d)*(fs2/fc) = 0.07739312
v = Asl,mid/(b*d)*(fsv/fc) = 0.07739312
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
---->
v < vs,y2 - LHS eq.(4.5) is satisfied
---->
su (4.9) = 0.19817337
Mu = MRc (4.14) = 6.6448E+007
u = su (4.1) = 2.4749691E-005

```

Calculation of ratio lb/d

Inadequate Lap Length with lb/d = 0.30

Calculation of Mu1-

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

$$\phi_u = 2.4749691E-005$$

$$M_u = 6.6448E+007$$

with full section properties:

$$b = 400.00$$

$$d = 258.00$$

$$d' = 42.00$$

$$\nu = 5.5617499E-005$$

$$N = 189.411$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_c) = 0.00553582$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00553582$$

$$\phi_{we} \text{ (5.4c)} = 0.00259035$$

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

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

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

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

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

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

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

$$b_k = 300.00$$

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

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

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$f_{t1} = 466.8167$$

$$f_{y1} = 389.0139$$

$$su_1 = 0.00512$$

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

$$l_o/l_{ou,min} = l_b/l_d = 0.30$$

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

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

For calculation of $\phi_{su1_nominal}$ and y_1 , sh_1 , f_{t1} , f_{y1} , it is considered
characteristic value $f_{sy1} = f_{s1}/1.2$, 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.

$$\text{with } f_{s1} = f_s = 389.0139$$

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

$$y_2 = 0.00140044$$

$$sh_2 = 0.0044814$$

$$f_{t2} = 466.8167$$

$$f_{y2} = 389.0139$$

$$su_2 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
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 $fs_2 = fs = 389.0139$
with $Es_2 = Es = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
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 $fsv = fs = 389.0139$
with $Es_v = Es = 200000.00$
 $1 = Asl_{ten}/(b * d) * (fs_1/f_c) = 0.05813483$
 $2 = Asl_{com}/(b * d) * (fs_2/f_c) = 0.05813483$
 $v = Asl_{mid}/(b * d) * (fsv/f_c) = 0.05813483$
and confined core properties:
 $b = 340.00$
 $d = 228.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_{ten}/(b * d) * (fs_1/f_c) = 0.07739312$
 $2 = Asl_{com}/(b * d) * (fs_2/f_c) = 0.07739312$
 $v = Asl_{mid}/(b * d) * (fsv/f_c) = 0.07739312$
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
 $v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied
--->
 $su (4.9) = 0.19817337$
 $Mu = MRc (4.14) = 6.6448E+007$
 $u = su (4.1) = 2.4749691E-005$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Mu_{2+}

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

$u = 2.4749691E-005$
 $Mu = 6.6448E+007$

with full section properties:

$b = 400.00$

$d = 258.00$
 $d' = 42.00$
 $v = 5.5617499E-005$
 $N = 189.411$
 $f_c = 33.00$
 $\phi (5A.5, TBDY) = 0.002$
 Final value of ϕ : $\phi^* = \text{shear_factor} * \text{Max}(\phi, \phi_c) = 0.00553582$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\phi = 0.00553582$
 $\phi_w (5.4c) = 0.00259035$
 $\phi_{se} ((5.4d), TBDY) = 0.15672608$
 $b_o = 240.00$
 $h_o = 340.00$
 $b_{i2} = 346400.00$
 $\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00261799$
 Expression ((5.4d), TBDY) for $\phi_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$\phi_{sh,x} (5.4d) = 0.00349066$
 $A_{sh} = A_{stir} * n_s = 78.53982$
 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), TBDY), TBDY: $\phi_c = 0.002$
 $\phi_c = \text{confinement factor} = 1.00$
 $y_1 = 0.00140044$
 $sh_1 = 0.0044814$
 $ft_1 = 466.8167$
 $fy_1 = 389.0139$
 $su_1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $su_1 = 0.4 * esu1_nominal ((5.5), TBDY) = 0.032$
 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 $fs_1 = fs = 389.0139$
 with $Es_1 = Es = 200000.00$
 $y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 466.8167$
 $fy_2 = 389.0139$
 $su_2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$
 $su_2 = 0.4 * esu2_nominal ((5.5), TBDY) = 0.032$
 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 $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 389.0139$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$

```

ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (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 = 0.30
    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 = 389.0139
    with Esv = Es = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.05813483
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05813483
    v = Asl,mid/(b*d)*(fsv/fc) = 0.05813483
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.07739312
    2 = Asl,com/(b*d)*(fs2/fc) = 0.07739312
    v = Asl,mid/(b*d)*(fsv/fc) = 0.07739312
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19817337
Mu = MRc (4.14) = 6.6448E+007
u = su (4.1) = 2.4749691E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

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

u = 2.4749691E-005

Mu = 6.6448E+007

with full section properties:

b = 400.00

d = 258.00

d' = 42.00

v = 5.5617499E-005

N = 189.411

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00553582

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

From (5.4b), TBDY: cu = 0.00553582

we (5.4c) = 0.00259035

ase ((5.4d), TBDY) = 0.15672608

bo = 240.00

ho = 340.00

```

bi2 = 346400.00
psh,min = Min(psh,x , psh,y) = 0.00261799
Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
-----
psh,x (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 = 0.002
c = confinement factor = 1.00
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
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 = 389.0139
with Es1 = Es = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
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 = 389.0139
with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
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 $f_{sv} = f_s = 389.0139$
 with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.05813483$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.05813483$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05813483$
 and confined core properties:
 $b = 340.00$
 $d = 228.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.07739312$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.07739312$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.07739312$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

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

$su (4.9) = 0.19817337$
 $\mu_u = M_{Rc} (4.14) = 6.6448E+007$
 $u = su (4.1) = 2.4749691E-005$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

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

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

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: $V_c = 88236.482$
 $= 1$ (normal-weight concrete)
 $f_c' = 33.00$, but $f_c'^{0.5} \leq 8.3 \text{ MPa}$ (22.5.3.1, ACI 318-14)
 $\rho_w = A_s/(b_w*d) = 0.00628319$
 A_s (tension reinf.) = 603.1858
 $b_w = 400.00$
 $d = 240.00$
 $V_u*d/\mu_u < 1 = 0.00$
 $\mu_u = 3.4215184E-013$
 $V_u = 8.6414578E-021$
 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 ' $V_w + f*V_f$ '
 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)

$\rho_w = A_s/(b_w \cdot d) = 0.00628319$

A_s (tension reinf.) = 603.1858

$b_w = 400.00$

$d = 240.00$

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

$M_u = 3.4215797E-013$

$V_u = 8.6414578E-021$

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, $\gamma = 0.90$

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

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 1850.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_b/l_d = 0.30$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 1.8189791E-011$

Shear Force, $V_2 = 2.9102230E-014$

Shear Force, $V_3 = 7491.862$

Axial Force, $F = -459.9979$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 615.7522$

-Compression: $A_{sc} = 911.0619$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{st,ten} = 508.938$

-Compression: $A_{sc,com} = 508.938$

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

Mean Diameter of Tension Reinforcement, $Db_L = 14.66667$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.00706586$

$$u = y + p = 0.00706586$$

- Calculation of y -

$$y = (M_y * L_s / 3) / E_{eff} = 0.00206586 \text{ ((4.29), Biskinis Phd)}$$

$$M_y = 4.8843E+007$$

$$L_s = M/V \text{ (with } L_s > 0.1 * L \text{ and } L_s < 2 * L) = 925.00$$

$$\text{From table 10.5, ASCE 41_17: } E_{eff} = 0.3 * E_c * I_g = 7.2898E+012$$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

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

$$y_{ten} = 8.1950237E-006$$

$$\text{with ((10.1), ASCE 41-17) } f_y = \text{Min}(f_y, 1.25 * f_y * (I_b / I_d)^{2/3}) = 311.2112$$

$$d = 258.00$$

$$y = 0.26403826$$

$$A = 0.01480903$$

$$B = 0.0086159$$

$$\text{with } p_t = 0.00493157$$

$$p_c = 0.00493157$$

$$p_v = 0.00493157$$

$$N = 459.9979$$

$$b = 400.00$$

$$" = 0.1627907$$

$$y_{comp} = 3.2314820E-005$$

$$\text{with } f_c = 33.00$$

$$E_c = 26999.444$$

$$y = 0.26388224$$

$$A = 0.01478458$$

$$B = 0.00860158$$

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

Calculation of ratio I_b / I_d

Inadequate Lap Length with $I_b / I_d = 0.30$

- Calculation of p -

From table 10-7: $p = 0.005$

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 $V_p / V_o = 0.37228966$

- Transverse Reinforcement: NC

- Stirrup Spacing $> d/3$

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

$$= -6.8371455E-022$$

- Stirrup Spacing $> d/2$

$$d = 258.00$$

$$s = 150.00$$

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

$V_s = 139627.457$, already given in calculation of shear control ratio

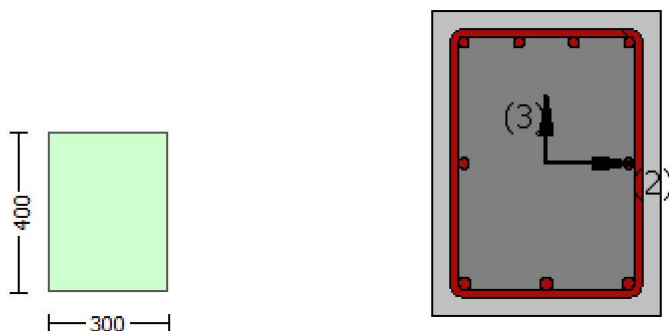
design Shear = $2.9102230E-014$

$\rho = \frac{A_{st}}{b_w d} = 0.00596659$
 Tension Reinf Area: $A_{st} = 615.7522$
 $\rho' = \frac{A_{sc}}{b_w d} = 0.00882812$
 Compression Reinf Area: $A_{sc} = 911.0619$
 From (B-1), ACI 318-11: $\rho = 0.01704017$
 $f_c = 33.00$
 $f_y = 555.56$
 From 10.2.7.3, ACI 318-11: $\lambda = 0.65$
 From fig R10.3.3, ACI 318-11 (Ence 454, too): $\frac{87000}{(87000 + f_y)} = \frac{c_b}{d} = 0.003 / (0.003 + \lambda y) = 0.51922877$
 $y = 0.0027778$
 $V / (b_w d f_c^{0.5}) = 5.9117060E-019$, 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, $\gamma = 0.90$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
 Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
 Consequently:
 New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 25.00$
 New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$
 Concrete Elasticity, $E_c = 26999.444$
 Steel Elasticity, $E_s = 200000.00$
 Section Height, $H = 400.00$
 Section Width, $W = 300.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 1850.00$
 Primary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Inadequate Lap Length with $l_o/l_{ou,min} = l_b/l_d = 0.30$
 No FRP Wrapping

Stepwise Properties

EDGE -A-
 Bending Moment, $M_a = -1.1438410E-010$
 Shear Force, $V_a = -4.6128812E-014$
 EDGE -B-
 Bending Moment, $M_b = 2.9032116E-011$
 Shear Force, $V_b = 4.6128812E-014$
 BOTH EDGES
 Axial Force, $F = -618.3078$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{st} = 603.1858$
 -Compression: $A_{sc} = 923.6282$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{st,ten} = 508.938$
 -Compression: $A_{st,com} = 508.938$
 -Middle: $A_{st,mid} = 508.938$
 Mean Diameter of Tension Reinforcement, $D_{bL,ten} = 14.66667$

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

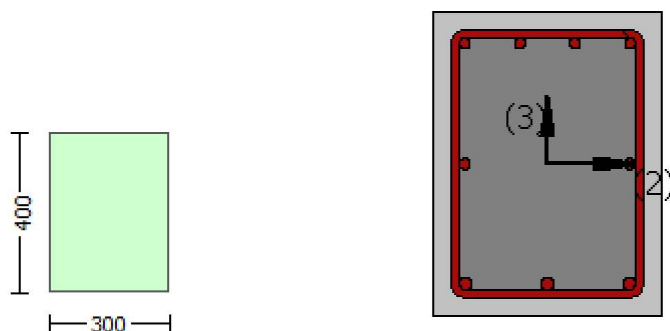
NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
 where V_f is the contribution of FRPs ((11.3), ACI 440).

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)
 $\rho_w = A_s/(b_w \cdot d) = 0.00628319$
 A_s (tension reinf.) = 603.1858
 $b_w = 400.00$
 $d = 240.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 1.1438410E-010$
 $V_u = 4.6128812E-014$
 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. 10

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: (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, $\phi = 0.90$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

#####

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 = 1.00

Element Length, $L = 1850.00$

Primary Member

Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with $l_o/l_{o,min} = 0.30$
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, $V_a = 2740.264$
EDGE -B-
Shear Force, $V_b = 2740.264$
BOTH EDGES
Axial Force, $F = -189.411$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 603.1858$
-Compression: $A_{sc} = 923.6282$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten} = 603.1858$
-Compression: $A_{sc,com} = 615.7522$
-Middle: $A_{sc,mid} = 307.8761$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.39580698$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 112670.646$
with
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 1.0175E+008$
 $\mu_{u1+} = 9.9812E+007$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{u1-} = 1.0175E+008$, 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
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 1.0162E+008$
 $\mu_{u2+} = 9.9934E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
 $\mu_{u2-} = 1.0162E+008$, 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
 $V_1 = 2740.264$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 2740.264$, 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:
 $\phi_u = 1.7580246E-005$
 $\mu_u = 9.9812E+007$

with full section properties:

$b = 300.00$
 $d = 357.00$
 $d' = 42.00$
 $v = 5.3592212E-005$
 $N = 189.411$
 $f_c = 33.00$
 $\phi_{co} (5A.5, TBDY) = 0.002$
Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \max(\phi_u, \phi_{co}) = 0.00553582$
The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $c_u = 0.00553582$
 w_e (5.4c) = 0.00259035
 a_{se} ((5.4d), TBDY) = 0.15672608
 $b_o = 240.00$
 $h_o = 340.00$
 $b_{i2} = 346400.00$
 $p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00261799$
 Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $p_{sh,x}$ (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: $c_c = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y_1 = 0.00140044$
 $sh_1 = 0.0044814$
 $ft_1 = 466.8167$
 $fy_1 = 389.0139$
 $su_1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $su_1 = 0.4 \cdot esu1_nominal$ ((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 $fs_1 = fs = 389.0139$
 with $Es_1 = Es = 200000.00$
 $y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 466.8167$
 $fy_2 = 389.0139$
 $su_2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$
 $su_2 = 0.4 \cdot esu2_nominal$ ((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_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 389.0139$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $suv = 0.4 \cdot esuv_nominal$ ((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 $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
with $f_{sv} = f_s = 389.0139$
with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.06639156$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.06777471$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.03388736$
and confined core properties:
 $b = 240.00$
 $d = 327.00$
 $d' = 12.00$
 $f_{cc} \text{ (5A.2, TBDY)} = 33.00$
 $cc \text{ (5A.5, TBDY)} = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.09060316$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.09249072$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.04624536$
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
--->
 $su \text{ (4.9)} = 0.18421297$
 $Mu = MR_c \text{ (4.14)} = 9.9812E+007$
 $u = su \text{ (4.1)} = 1.7580246E-005$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Mu_1 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.7569691E-005$
 $Mu = 1.0175E+008$

with full section properties:
 $b = 300.00$
 $d = 358.00$
 $d' = 43.00$
 $v = 5.3442513E-005$
 $N = 189.411$
 $f_c = 33.00$
 $co \text{ (5A.5, TBDY)} = 0.002$
Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.00553582$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $cu = 0.00553582$
 $w_e \text{ (5.4c)} = 0.00259035$
 $ase \text{ ((5.4d), TBDY)} = 0.15672608$
 $bo = 240.00$
 $ho = 340.00$
 $bi2 = 346400.00$
 $psh,min = \text{Min}(psh,x, psh,y) = 0.00261799$
Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

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

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 = 0.002

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30

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 = 389.0139

with Es1 = Es = 200000.00

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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 = 389.0139

with Es2 = Es = 200000.00

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30

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 = 389.0139

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.0675854

2 = Asl,com/(b*d)*(fs2/fc) = 0.06620611

v = Asl,mid/(b*d)*(fsv/fc) = 0.0337927

and confined core properties:

b = 240.00

d = 328.00

```

d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
  c = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.09220874
  2 = Asl,com/(b*d)*(fs2/fc) = 0.09032693
  v = Asl,mid/(b*d)*(fsv/fc) = 0.04610437
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18600297
Mu = MRc (4.14) = 1.0175E+008
u = su (4.1) = 1.7569691E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

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

```

u = 1.7539903E-005
Mu = 9.9934E+007

```

with full section properties:

```

b = 300.00
d = 358.00
d' = 43.00
v = 5.3442513E-005
N = 189.411
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00553582
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00553582
we (5.4c) = 0.00259035
ase ((5.4d), TBDY) = 0.15672608
bo = 240.00
ho = 340.00
bi2 = 346400.00
psh,min = Min(psh,x , psh,y) = 0.00261799

```

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

```

psh,x (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 = 0.002
c = confinement factor = 1.00
y1 = 0.00140044

```

```

sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
    using (30) in Biskinis/Fardis (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 = 0.30
    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 = 389.0139
    with Es1 = Es = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
    using (30) in Biskinis/Fardis (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 = 0.30
    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 = 389.0139
    with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (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 = 0.30
    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 = 389.0139
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06620611
2 = Asl,com/(b*d)*(fs2/fc) = 0.0675854
v = Asl,mid/(b*d)*(fsv/fc) = 0.0337927
and confined core properties:
b = 240.00
d = 328.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.09032693
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09220874
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04610437
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18462058

```

$$\begin{aligned} \mu_u &= M/R_c (4.14) = 9.9934E+007 \\ u &= s_u (4.1) = 1.7539903E-005 \end{aligned}$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_u

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

$$\begin{aligned} u &= 1.7610316E-005 \\ \mu_u &= 1.0162E+008 \end{aligned}$$

with full section properties:

$$\begin{aligned} b &= 300.00 \\ d &= 357.00 \\ d' &= 42.00 \\ v &= 5.3592212E-005 \\ N &= 189.411 \\ f_c &= 33.00 \\ c_o (5A.5, \text{TB DY}) &= 0.002 \\ \text{Final value of } \mu_u: \mu_u^* &= \text{shear_factor} * \text{Max}(\mu_u, c_o) = 0.00553582 \\ \text{The Shear_factor is considered equal to 1 (pure moment strength)} \\ \text{From (5.4b), TB DY: } \mu_u &= 0.00553582 \\ w_e (5.4c) &= 0.00259035 \\ a_{se} ((5.4d), \text{TB DY}) &= 0.15672608 \\ b_o &= 240.00 \\ h_o &= 340.00 \\ b_{i2} &= 346400.00 \end{aligned}$$

$\mu_{sh,min} = \text{Min}(\mu_{sh,x}, \mu_{sh,y}) = 0.00261799$
Expression ((5.4d), TB DY) for $\mu_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\begin{aligned} \mu_{sh,x} (5.4d) &= 0.00349066 \\ A_{sh} &= A_{stir} * n_s = 78.53982 \\ \text{No stirrups, } n_s &= 2.00 \\ b_k &= 300.00 \end{aligned}$$

$$\begin{aligned} \mu_{sh,y} (5.4d) &= 0.00261799 \\ A_{sh} &= A_{stir} * n_s = 78.53982 \\ \text{No stirrups, } n_s &= 2.00 \\ b_k &= 400.00 \end{aligned}$$

$$\begin{aligned} s &= 150.00 \\ f_{ywe} &= 694.45 \\ f_{ce} &= 33.00 \\ \text{From ((5.A5), TB DY), TB DY: } c_c &= 0.002 \\ c &= \text{confinement factor} = 1.00 \\ y_1 &= 0.00140044 \\ sh_1 &= 0.0044814 \\ ft_1 &= 466.8167 \\ fy_1 &= 389.0139 \\ su_1 &= 0.00512 \\ \text{using (30) in Biskinis/Fardis (2013) multiplied with shear_factor} \\ \text{and also multiplied by the shear_factor according to 15.7.1.4, with} \\ \text{Shear_factor} &= 1.00 \\ l_o/l_{ou,min} &= l_b/l_d = 0.30 \\ su_1 &= 0.4 * esu_1_{nominal} ((5.5), \text{TB DY}) = 0.032 \\ \text{From table 5A.1, TB DY: } esu_1_{nominal} &= 0.08, \\ \text{For calculation of } esu_1_{nominal} \text{ and } y_1, sh_1, ft_1, fy_1, \text{ it is considered} \\ \text{characteristic value } fsy_1 &= fs_1/1.2, \text{ from table 5.1, TB DY.} \\ y_1, sh_1, ft_1, fy_1, &\text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b/l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.} \end{aligned}$$

```

with fs1 = fs = 389.0139
with Es1 = Es = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
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 = 389.0139
with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30
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 = 389.0139
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06777471
2 = Asl,com/(b*d)*(fs2/fc) = 0.06639156
v = Asl,mid/(b*d)*(fsv/fc) = 0.03388736
and confined core properties:
b = 240.00
d = 327.00
d' = 12.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09249072
2 = Asl,com/(b*d)*(fs2/fc) = 0.09060316
v = Asl,mid/(b*d)*(fsv/fc) = 0.04624536
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18560594
Mu = MRc (4.14) = 1.0162E+008
u = su (4.1) = 1.7610316E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 284660.584$

Calculation of Shear Strength at edge 1, $V_{r1} = 284660.584$
 $V_{r1} = V_n ((22.5.1.1), \text{ACI } 318-14)$

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: $V_c = 98490.641$
= 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)
 $\rho_w = A_s/(b_w*d) = 0.00628319$
 A_s (tension reinf.) = 603.1858
 $b_w = 300.00$
 $d = 320.00$
 $V_u*d/\mu_u < 1 = 1.00$
 $\mu_u = 69262.055$
 $V_u = 2740.264$

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, $V_{r2} = 284660.584$
 $V_{r2} = V_n ((22.5.1.1), \text{ACI } 318-14)$

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: $V_c = 98490.641$
= 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)
 $\rho_w = A_s/(b_w*d) = 0.00628319$
 A_s (tension reinf.) = 603.1858
 $b_w = 300.00$
 $d = 320.00$
 $V_u*d/\mu_u < 1 = 1.00$
 $\mu_u = 69262.055$
 $V_u = 2740.264$

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: $V_s + V_f \leq 366348.956$

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, $\phi = 0.90$
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$
Concrete Elasticity, $E_c = 26999.444$

```

Steel Elasticity, Es = 200000.00
#####
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45
#####
Section Height, H = 400.00
Section Width, W = 300.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 1850.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lo,min = 0.30
No FRP Wrapping
-----

Stepwise Properties
-----
At local axis: 2
EDGE -A-
Shear Force, Va = -8.6414578E-021
EDGE -B-
Shear Force, Vb = 8.6414578E-021
BOTH EDGES
Axial Force, F = -189.411
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 603.1858
-Compression: Aslc = 923.6282
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 508.938
-Compression: Asl,com = 508.938
-Middle: Asl,mid = 508.938
-----
-----

Calculation of Shear Capacity ratio , Ve/Vr = 0.37228966
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln ± vu*ln/2 = 71835.924
with
Mpr1 = Max(Mu1+ , Mu1-) = 6.6448E+007
Mu1+ = 6.6448E+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
Mu1- = 6.6448E+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
Mpr2 = Max(Mu2+ , Mu2-) = 6.6448E+007
Mu2+ = 6.6448E+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
Mu2- = 6.6448E+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
± vu*ln = (|V1| + |V2|)/2
with
V1 = -8.6414578E-021, is the shear force acting at edge 1 for the the static loading combination
V2 = 8.6414578E-021, is the shear force acting at edge 2 for the the static loading combination
-----

Calculation of Mu1+
-----

-----

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 2.4749691E-005

```


$$\mu_u = 6.6448E+007$$

with full section properties:

$$b = 400.00$$

$$d = 258.00$$

$$d' = 42.00$$

$$v = 5.5617499E-005$$

$$N = 189.411$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_{cu} = \phi_{cu} * \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00553582$$

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

$$\text{From (5.4b), TB DY: } \phi_{cu} = 0.00553582$$

$$\phi_{we} (5.4c) = 0.00259035$$

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

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_i^2 = 346400.00$$

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

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

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

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

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

$$b_k = 300.00$$

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

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

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$f_{t1} = 466.8167$$

$$f_{y1} = 389.0139$$

$$su_1 = 0.00512$$

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

$$l_o/l_{ou,min} = l_b/l_d = 0.30$$

$$su_1 = 0.4 * esu1_{nominal} ((5.5), \text{TB DY}) = 0.032$$

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

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.

$y_1, sh_1, f_{t1}, f_{y1}$, are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_1 = fs = 389.0139$$

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

$$y_2 = 0.00140044$$

$$sh_2 = 0.0044814$$

$$f_{t2} = 466.8167$$

$$f_{y2} = 389.0139$$

$$su_2 = 0.00512$$

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

$$l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$$

$$su_2 = 0.4 * esu2_{nominal} ((5.5), \text{TB DY}) = 0.032$$

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

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.

$y_1, sh_1, f_{t1}, f_{y1}$, are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

```

with fs2 = fs = 389.0139
with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30
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 = 389.0139
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05813483
2 = Asl,com/(b*d)*(fs2/fc) = 0.05813483
v = Asl,mid/(b*d)*(fsv/fc) = 0.05813483
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07739312
2 = Asl,com/(b*d)*(fs2/fc) = 0.07739312
v = Asl,mid/(b*d)*(fsv/fc) = 0.07739312
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19817337
Mu = MRc (4.14) = 6.6448E+007
u = su (4.1) = 2.4749691E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

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

```

u = 2.4749691E-005
Mu = 6.6448E+007

```

with full section properties:

```

b = 400.00
d = 258.00
d' = 42.00
v = 5.5617499E-005
N = 189.411
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00553582
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00553582

```

w_e (5.4c) = 0.00259035
 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
 Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x}$ (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 = 0.002
 c = confinement factor = 1.00
 y_1 = 0.00140044
 sh_1 = 0.0044814
 ft_1 = 466.8167
 fy_1 = 389.0139
 su_1 = 0.00512
 using (30) in Biskinis/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 = 0.30
 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 = 389.0139
 with Es_1 = Es = 200000.00
 y_2 = 0.00140044
 sh_2 = 0.0044814
 ft_2 = 466.8167
 fy_2 = 389.0139
 su_2 = 0.00512
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min}$ = $l_b/l_{b,min}$ = 0.30
 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 = 389.0139
 with Es_2 = Es = 200000.00
 y_v = 0.00140044
 sh_v = 0.0044814
 ft_v = 466.8167
 fy_v = 389.0139
 su_v = 0.00512
 using (30) in Biskinis/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 = 0.30
 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 , fy_v , it is considered characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.

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

with $f_{sv} = f_s = 389.0139$

with $E_{sv} = E_s = 200000.00$

$1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.05813483$

$2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.05813483$

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.05813483$

and confined core properties:

$b = 340.00$

$d = 228.00$

$d' = 12.00$

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

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

$1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.07739312$

$2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.07739312$

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.07739312$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.19817337

$Mu = MR_c$ (4.14) = 6.6448E+007

$u = su$ (4.1) = 2.4749691E-005

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Mu_{2+}

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

$u = 2.4749691E-005$

$Mu = 6.6448E+007$

with full section properties:

$b = 400.00$

$d = 258.00$

$d' = 42.00$

$v = 5.5617499E-005$

$N = 189.411$

$f_c = 33.00$

co (5A.5, TBDY) = 0.002

Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.00553582$

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

From (5.4b), TBDY: $cu = 0.00553582$

w_e (5.4c) = 0.00259035

ase ((5.4d), TBDY) = 0.15672608

$bo = 240.00$

$ho = 340.00$

$bi2 = 346400.00$

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

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

psh,x (5.4d) = 0.00349066

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

No stirrups, $n_s = 2.00$

$bk = 300.00$

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 = 0.002
 c = confinement factor = 1.00

y1 = 0.00140044
 sh1 = 0.0044814
 ft1 = 466.8167
 fy1 = 389.0139
 su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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 = 389.0139

with Es1 = Es = 200000.00

y2 = 0.00140044
 sh2 = 0.0044814
 ft2 = 466.8167
 fy2 = 389.0139
 su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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 = 389.0139

with Es2 = Es = 200000.00

yv = 0.00140044
 shv = 0.0044814
 ftv = 466.8167
 fyv = 389.0139
 suv = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30

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 = 389.0139

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.05813483

2 = Asl,com/(b*d)*(fs2/fc) = 0.05813483

v = Asl,mid/(b*d)*(fsv/fc) = 0.05813483

and confined core properties:

b = 340.00
 d = 228.00
 d' = 12.00

```

fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07739312
2 = Asl,com/(b*d)*(fs2/fc) = 0.07739312
v = Asl,mid/(b*d)*(fsv/fc) = 0.07739312
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19817337
Mu = MRc (4.14) = 6.6448E+007
u = su (4.1) = 2.4749691E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

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

u = 2.4749691E-005

Mu = 6.6448E+007

with full section properties:

b = 400.00

d = 258.00

d' = 42.00

v = 5.5617499E-005

N = 189.411

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00553582

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

From (5.4b), TBDY: cu = 0.00553582

we (5.4c) = 0.00259035

ase ((5.4d), TBDY) = 0.15672608

bo = 240.00

ho = 340.00

bi2 = 346400.00

psh,min = Min(psh,x , psh,y) = 0.00261799

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

psh,x (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 = 0.002

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

```

ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
    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 = 389.0139
    with Es1 = Es = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
    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 = 389.0139
    with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
    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 = 389.0139
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05813483
2 = Asl,com/(b*d)*(fs2/fc) = 0.05813483
v = Asl,mid/(b*d)*(fsv/fc) = 0.05813483
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07739312
2 = Asl,com/(b*d)*(fs2/fc) = 0.07739312
v = Asl,mid/(b*d)*(fsv/fc) = 0.07739312
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19817337
Mu = MRc (4.14) = 6.6448E+007

```

$$u = su(4.1) = 2.4749691E-005$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

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)
 $\rho_w = A_s/(b_w*d) = 0.00628319$
 A_s (tension reinf.) = 603.1858
 $b_w = 400.00$
 $d = 240.00$
 $V_u*d/M_u < 1 = 0.00$
 $M_u = 3.4215184E-013$
 $V_u = 8.6414578E-021$

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)
 $\rho_w = A_s/(b_w*d) = 0.00628319$
 A_s (tension reinf.) = 603.1858
 $b_w = 400.00$
 $d = 240.00$
 $V_u*d/M_u < 1 = 0.00$
 $M_u = 3.4215797E-013$
 $V_u = 8.6414578E-021$

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, $\phi = 0.90$

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

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 1850.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_b/l_d = 0.30$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 6.9042E+006$

Shear Force, $V_2 = -4.6128812E-014$

Shear Force, $V_3 = -4791.309$

Axial Force, $F = -618.3078$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 603.1858$

-Compression: $A_{sc} = 923.6282$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{st,ten} = 603.1858$

-Compression: $A_{sc,com} = 615.7522$

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

Mean Diameter of Tension Reinforcement, $DbL = 16.00$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $\phi_{u,R} = 1.0^* \phi_u = 0.02261926$

$\phi_u = \phi_y + \phi_p = 0.02261926$

- Calculation of ϕ_y -

$\phi_y = (M_y * L_s / 3) / E_{eff} = 0.00261926 ((4.29), Biskinis Phd))$

$M_y = 7.0670E+007$

$L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 1440.988

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 ϕ_y and M_y according to Annex 7 -

$\phi_y = \min(\phi_{y,ten}, \phi_{y,com})$

$\phi_{y,ten} = 5.8351625E-006$

with ((10.1), ASCE 41-17) $f_y = \min(f_y, 1.25 * f_y * (l_b/l_d)^{2/3}) = 311.2112$

$d = 357.00$
 $y = 0.25302858$
 $A = 0.01427452$
 $B = 0.00793336$
 with $p_t = 0.00563199$
 $p_c = 0.00574932$
 $p_v = 0.00287466$
 $N = 618.3078$
 $b = 300.00$
 $" = 0.11764706$
 $y_{comp} = 2.4376298E-005$
 with $f_c = 33.00$
 $E_c = 26999.444$
 $y = 0.25281081$
 $A = 0.01424285$
 $B = 0.00791481$
 with $E_s = 200000.00$

Calculation of ratio I_b/I_d

Inadequate Lap Length with $I_b/I_d = 0.30$

- 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 $V_p/V_o = 0.39580698$

- Transverse Reinforcement: NC

- Stirrup Spacing $> d/3$

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

$= 6.1566510E-005$

- 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 = 4791.309

- $(\rho - \rho')/b_w d = -0.17558466$

$= A_{st}/(b_w d) = 0.00563199$

Tension Reinf Area: $A_{st} = 603.1858$

$\rho' = A_{sc}/(b_w d) = 0.00862398$

Compression Reinf Area: $A_{sc} = 923.6282$

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): $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + \gamma) = 0.51922877$

$\gamma = 0.0027778$

- $V/(b_w d f_c^{0.5}) = 0.09378448$, 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

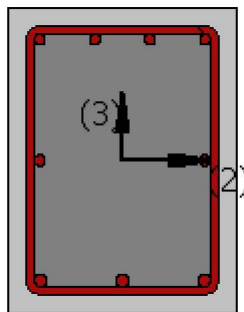
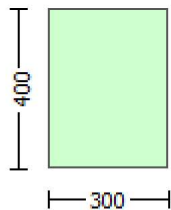
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

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, $\gamma = 0.90$

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

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 1850.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{ou,min} = l_b/l_d = 0.30$

No FRP Wrapping

Stepwise Properties

EDGE -A-
 Bending Moment, $M_a = 6.9042E+006$
 Shear Force, $V_a = -4791.309$
 EDGE -B-
 Bending Moment, $M_b = 7.0292E+006$
 Shear Force, $V_b = 10271.838$
 BOTH EDGES
 Axial Force, $F = -618.3078$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{sl,t} = 603.1858$
 -Compression: $A_{sl,c} = 923.6282$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{sl,ten} = 603.1858$
 -Compression: $A_{sl,com} = 615.7522$
 -Middle: $A_{sl,mid} = 307.8761$
 Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 16.00$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 246628.748$
 V_n ((22.5.1.1), ACI 318-14) = 246628.748

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: $V_c = 79077.14$
 = 1 (normal-weight concrete)
 $f_c' = 25.00$, but $f_c'^{0.5} \leq 8.3$ MPa ((22.5.3.1), ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00628319$
 A_s (tension reinf.) = 603.1858
 $b_w = 300.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 0.22206992$
 $M_u = 6.9042E+006$
 $V_u = 4791.309$

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 ($s \leq d/2$, according to ASCE 41-17, 10.3.4)

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

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

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

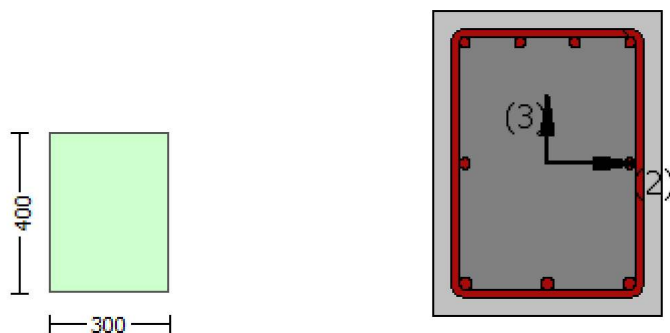
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (μ)

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, $\gamma = 0.90$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

#####

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 = 1.00

Element Length, $L = 1850.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{ou,min} = 0.30$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 2740.264$

EDGE -B-

Shear Force, $V_b = 2740.264$
 BOTH EDGES
 Axial Force, $F = -189.411$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 603.1858$
 -Compression: $As_c = 923.6282$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 603.1858$
 -Compression: $As_{c,com} = 615.7522$
 -Middle: $As_{mid} = 307.8761$

 Calculation of Shear Capacity ratio, $V_e/V_r = 0.39580698$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 112670.646$
 with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 1.0175E+008$
 $\mu_{u1+} = 9.9812E+007$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
 which is defined for the static loading combination
 $\mu_{u1-} = 1.0175E+008$, 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
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 1.0162E+008$
 $\mu_{u2+} = 9.9934E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
 which is defined for the the static loading combination
 $\mu_{u2-} = 1.0162E+008$, 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
 $V_1 = 2740.264$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 2740.264$, is the shear force acting at edge 2 for the the static loading combination

 Calculation of μ_{u1+}

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

$\mu_u = 1.7580246E-005$
 $\mu_u = 9.9812E+007$

 with full section properties:

$b = 300.00$
 $d = 357.00$
 $d' = 42.00$
 $v = 5.3592212E-005$
 $N = 189.411$
 $f_c = 33.00$
 $\phi_c (5A.5, \text{TB DY}) = 0.002$
 Final value of ϕ_c : $\phi_c^* = \text{shear_factor} \cdot \text{Max}(\phi_c, \phi_c) = 0.00553582$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TB DY: $\phi_c = 0.00553582$
 $\phi_w (5.4c) = 0.00259035$
 $\phi_{se} ((5.4d), \text{TB DY}) = 0.15672608$
 $b_o = 240.00$
 $h_o = 340.00$
 $b_{i2} = 346400.00$
 $\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00261799$
 Expression ((5.4d), TB DY) for $\phi_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without
 earthquake detailing (90° closed stirrups)

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

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 = 0.002
 c = confinement factor = 1.00

y1 = 0.00140044
 sh1 = 0.0044814
 ft1 = 466.8167
 fy1 = 389.0139
 su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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 = 389.0139

with Es1 = Es = 200000.00

y2 = 0.00140044
 sh2 = 0.0044814
 ft2 = 466.8167
 fy2 = 389.0139
 su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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 = 389.0139

with Es2 = Es = 200000.00

yv = 0.00140044
 shv = 0.0044814
 ftv = 466.8167
 fyv = 389.0139
 suv = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30

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 = 389.0139

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.06639156

2 = Asl,com/(b*d)*(fs2/fc) = 0.06777471

v = Asl,mid/(b*d)*(fsv/fc) = 0.03388736

and confined core properties:

b = 240.00
 d = 327.00
 d' = 12.00

```

fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09060316
2 = Asl,com/(b*d)*(fs2/fc) = 0.09249072
v = Asl,mid/(b*d)*(fsv/fc) = 0.04624536
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18421297
Mu = MRc (4.14) = 9.9812E+007
u = su (4.1) = 1.7580246E-005

```

Calculation of ratio lb/l_d

Inadequate Lap Length with lb/l_d = 0.30

Calculation of Mu1-

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

u = 1.7569691E-005

Mu = 1.0175E+008

with full section properties:

b = 300.00

d = 358.00

d' = 43.00

v = 5.3442513E-005

N = 189.411

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00553582

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

From (5.4b), TBDY: cu = 0.00553582

we (5.4c) = 0.00259035

ase ((5.4d), TBDY) = 0.15672608

bo = 240.00

ho = 340.00

bi2 = 346400.00

psh,min = Min(psh,x , psh,y) = 0.00261799

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

psh,x (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 = 0.002

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814


```

ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
    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 = 389.0139
    with Es1 = Es = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
    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 = 389.0139
    with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
    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 = 389.0139
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0675854
2 = Asl,com/(b*d)*(fs2/fc) = 0.06620611
v = Asl,mid/(b*d)*(fsv/fc) = 0.0337927
and confined core properties:
b = 240.00
d = 328.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.09220874
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09032693
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04610437
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18600297
Mu = MRc (4.14) = 1.0175E+008

```

$$u = su(4.1) = 1.7569691E-005$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_{u2}

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

$$\mu_u = 1.7539903E-005$$

$$\mu_u = 9.9934E+007$$

with full section properties:

$$b = 300.00$$

$$d = 358.00$$

$$d' = 43.00$$

$$v = 5.3442513E-005$$

$$N = 189.411$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu_{cu}: \mu_{cu}^* = \text{shear_factor} * \text{Max}(\mu_{cu}, \mu_{cc}) = 0.00553582$$

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

$$\text{From (5.4b), TB DY: } \mu_{cu} = 0.00553582$$

$$\mu_{we}(5.4c) = 0.00259035$$

$$\alpha_{ase}((5.4d), \text{TB DY}) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

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

Expression $\alpha_{ase}((5.4d), \text{TB DY})$ for $\mu_{psh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

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

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

$$b_k = 300.00$$

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

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

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

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

$$l_o/l_{ou,min} = l_b/l_d = 0.30$$

$$su_1 = 0.4 * su_{1,nominal}((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } su_{1,nominal} = 0.08,$$

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

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

$$\text{with } fs_1 = fs = 389.0139$$

```

    with Es1 = Es = 200000.00
    y2 = 0.00140044
    sh2 = 0.0044814
    ft2 = 466.8167
    fy2 = 389.0139
    su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
    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 = 389.0139
    with Es2 = Es = 200000.00
    yv = 0.00140044
    shv = 0.0044814
    ftv = 466.8167
    fyv = 389.0139
    suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 0.30
    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 = 389.0139
    with Esv = Es = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.06620611
    2 = Asl,com/(b*d)*(fs2/fc) = 0.0675854
    v = Asl,mid/(b*d)*(fsv/fc) = 0.0337927
    and confined core properties:
    b = 240.00
    d = 328.00
    d' = 13.00
    fcc (5A.2, TBDY) = 33.00
    cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.09032693
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09220874
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04610437
    Case/Assumption: Unconfined full section - Steel rupture
    ' satisfies Eq. (4.3)
    --->
    v < vs,y2 - LHS eq.(4.5) is satisfied
    --->
    su (4.9) = 0.18462058
    Mu = MRc (4.14) = 9.9934E+007
    u = su (4.1) = 1.7539903E-005

```

Calculation of ratio lb/lb

Inadequate Lap Length with lb/lb = 0.30

Calculation of Mu2-

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

$$\phi_u = 1.7610316E-005$$

$$\mu_u = 1.0162E+008$$

with full section properties:

$$b = 300.00$$

$$d = 357.00$$

$$d' = 42.00$$

$$v = 5.3592212E-005$$

$$N = 189.411$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00553582$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00553582$$

$$\phi_{we} (5.4c) = 0.00259035$$

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

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_i^2 = 346400.00$$

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

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

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

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

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

$$b_k = 300.00$$

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

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

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$f_{t1} = 466.8167$$

$$f_{y1} = 389.0139$$

$$su_1 = 0.00512$$

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

$$l_o/l_{ou,min} = l_b/l_d = 0.30$$

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

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

For calculation of $esu1_{nominal}$ and y_1 , sh_1 , f_{t1} , f_{y1} , it is considered
characteristic value $f_{s1} = f_s/1.2$, from table 5.1, TBDY.

$$y_1, sh_1, f_{t1}, f_{y1}, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b/l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } f_{s1} = f_s = 389.0139$$

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

$$y_2 = 0.00140044$$

$$sh_2 = 0.0044814$$

$$f_{t2} = 466.8167$$

$$f_{y2} = 389.0139$$

$$su_2 = 0.00512$$

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

$$l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$$

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

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

For calculation of $esu2_{nominal}$ and y_2 , sh_2 , f_{t2} , f_{y2} , it is considered

characteristic value $fs_2 = fs_2/1.2$, 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 $fs_2 = fs = 389.0139$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lo_{u,min} = lb/ld = 0.30$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fs_v = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fs_v = fs_v/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = fs = 389.0139$
 with $Es_v = Es = 200000.00$
 $1 = As_{l,ten}/(b \cdot d) \cdot (fs_1/f_c) = 0.06777471$
 $2 = As_{l,com}/(b \cdot d) \cdot (fs_2/f_c) = 0.06639156$
 $v = As_{l,mid}/(b \cdot d) \cdot (fs_v/f_c) = 0.03388736$
 and confined core properties:
 $b = 240.00$
 $d = 327.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = As_{l,ten}/(b \cdot d) \cdot (fs_1/f_c) = 0.09249072$
 $2 = As_{l,com}/(b \cdot d) \cdot (fs_2/f_c) = 0.09060316$
 $v = As_{l,mid}/(b \cdot d) \cdot (fs_v/f_c) = 0.04624536$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.18560594$
 $Mu = MRc (4.14) = 1.0162E+008$
 $u = su (4.1) = 1.7610316E-005$

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 284660.584$

Calculation of Shear Strength at edge 1, $V_{r1} = 284660.584$
 $V_{r1} = V_n ((22.5.1.1), ACI 318-14)$

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: $V_c = 98490.641$
 $= 1$ (normal-weight concrete)
 $f'_c = 33.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $pw = As/(bw \cdot d) = 0.00628319$
 As (tension reinf.) = 603.1858
 $bw = 300.00$
 $d = 320.00$
 $V_u \cdot d / Mu < 1 = 1.00$

$$\mu_u = 69262.055$$

$$V_u = 2740.264$$

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

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

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, $V_{r2} = 284660.584$

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

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).

$$\text{From Table (22.5.5.1), ACI 318-14: } V_c = 98490.641$$

= 1 (normal-weight concrete)

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

$$p_w = A_s / (b_w \cdot d) = 0.00628319$$

$$A_s \text{ (tension reinf.)} = 603.1858$$

$$b_w = 300.00$$

$$d = 320.00$$

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

$$\mu_u = 69262.055$$

$$V_u = 2740.264$$

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

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 150.00$$

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

$$\text{Knowledge Factor, } \phi = 0.90$$

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

Consequently:

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

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

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

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

#####

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

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

#####

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

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

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

$$\text{Mean Confinement Factor overall section} = 1.00$$

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

Primary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with $l_o/l_{ou,min} = 0.30$
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = -8.6414578E-021$
EDGE -B-
Shear Force, $V_b = 8.6414578E-021$
BOTH EDGES
Axial Force, $F = -189.411$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $Asl_t = 603.1858$
-Compression: $Asl_c = 923.6282$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $Asl_{ten} = 508.938$
-Compression: $Asl_{com} = 508.938$
-Middle: $Asl_{mid} = 508.938$

Calculation of Shear Capacity ratio , $V_e/V_r = 0.37228966$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 71835.924$
with
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 6.6448E+007$
 $Mu_{1+} = 6.6448E+007$, 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
 $Mu_{1-} = 6.6448E+007$, 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
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 6.6448E+007$
 $Mu_{2+} = 6.6448E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
 $Mu_{2-} = 6.6448E+007$, 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
 $V_1 = -8.6414578E-021$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 8.6414578E-021$, 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:
 $\phi_u = 2.4749691E-005$
 $M_u = 6.6448E+007$

with full section properties:

$b = 400.00$
 $d = 258.00$
 $d' = 42.00$
 $v = 5.5617499E-005$
 $N = 189.411$
 $f_c = 33.00$
 $\phi_o (5A.5, TBDY) = 0.002$
Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_o) = 0.00553582$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\phi_u = 0.00553582$
we (5.4c) = 0.00259035

$ase((5.4d), TBDY) = 0.15672608$
 $bo = 240.00$
 $ho = 340.00$
 $bi2 = 346400.00$
 $psh,min = \text{Min}(psh,x, psh,y) = 0.00261799$
 Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

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

$s = 150.00$
 $fywe = 694.45$
 $fce = 33.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 466.8167$
 $fy1 = 389.0139$
 $su1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/d = 0.30$
 $su1 = 0.4*esu1_nominal((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu1_nominal = 0.08$,
 For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25*(lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = fs = 389.0139$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 466.8167$
 $fy2 = 389.0139$
 $su2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/lb,min = 0.30$
 $su2 = 0.4*esu2_nominal((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25*(lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = fs = 389.0139$
 with $Es2 = Es = 200000.00$
 $yv = 0.00140044$
 $shv = 0.0044814$
 $ftv = 466.8167$
 $fyv = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/d = 0.30$
 $suv = 0.4*esuv_nominal((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

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

γ_1 , ϕ_1 , ϕ_{f1} , ϕ_{f1} , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $f_{sv} = f_s = 389.0139$

with $E_{sv} = E_s = 200000.00$

$1 = A_{s1,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.05813483$

$2 = A_{s2,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.05813483$

$v = A_{s,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.05813483$

and confined core properties:

$b = 340.00$

$d = 228.00$

$d' = 12.00$

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

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

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

$1 = A_{s1,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.07739312$

$2 = A_{s2,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.07739312$

$v = A_{s,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.07739312$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$\mu_u \text{ (4.9)} = 0.19817337$

$\mu_u = M_{Rc} \text{ (4.14)} = 6.6448E+007$

$u = \mu_u \text{ (4.1)} = 2.4749691E-005$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_{u1} -

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

$u = 2.4749691E-005$

$\mu_u = 6.6448E+007$

with full section properties:

$b = 400.00$

$d = 258.00$

$d' = 42.00$

$v = 5.5617499E-005$

$N = 189.411$

$f_c = 33.00$

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

Final value of μ_u : $\mu_u^* = \text{shear_factor} \cdot \text{Max}(\mu_u, c_c) = 0.00553582$

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

From (5.4b), TBDY: $\mu_u = 0.00553582$

$w_e \text{ (5.4c)} = 0.00259035$

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

$b_o = 240.00$

$h_o = 340.00$

$b_{i2} = 346400.00$

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

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

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

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

No stirrups, $n_s = 2.00$

$b_k = 300.00$

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 = 0.002
c = confinement factor = 1.00

y1 = 0.00140044
sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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 = 389.0139

with Es1 = Es = 200000.00

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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 = 389.0139

with Es2 = Es = 200000.00

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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 = 389.0139

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.05813483

2 = Asl,com/(b*d)*(fs2/fc) = 0.05813483

v = Asl,mid/(b*d)*(fsv/fc) = 0.05813483

and confined core properties:

b = 340.00

d = 228.00

d' = 12.00

fcc (5A.2, TBDY) = 33.00

```

cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07739312
2 = Asl,com/(b*d)*(fs2/fc) = 0.07739312
v = Asl,mid/(b*d)*(fsv/fc) = 0.07739312
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19817337
Mu = MRc (4.14) = 6.6448E+007
u = su (4.1) = 2.4749691E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

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

```

u = 2.4749691E-005
Mu = 6.6448E+007

```

with full section properties:

```

b = 400.00
d = 258.00
d' = 42.00
v = 5.5617499E-005
N = 189.411
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00553582
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00553582
we (5.4c) = 0.00259035
ase ((5.4d), TBDY) = 0.15672608
bo = 240.00
ho = 340.00
bi2 = 346400.00
psh,min = Min(psh,x , psh,y) = 0.00261799
Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

```

```

psh,x (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 = 0.002
c = confinement factor = 1.00
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167

```

```

fy1 = 389.0139
su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 0.30
    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 = 389.0139
    with Es1 = Es = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
    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 = 389.0139
    with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 0.30
    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 = 389.0139
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05813483
2 = Asl,com/(b*d)*(fs2/fc) = 0.05813483
v = Asl,mid/(b*d)*(fsv/fc) = 0.05813483
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07739312
2 = Asl,com/(b*d)*(fs2/fc) = 0.07739312
v = Asl,mid/(b*d)*(fsv/fc) = 0.07739312
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19817337
Mu = MRc (4.14) = 6.6448E+007
u = su (4.1) = 2.4749691E-005

```

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_2 -

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

$$\mu = 2.4749691E-005$$

$$\mu_2 = 6.6448E+007$$

with full section properties:

$$b = 400.00$$

$$d = 258.00$$

$$d' = 42.00$$

$$v = 5.5617499E-005$$

$$N = 189.411$$

$$f_c = 33.00$$

$$\omega_0 (5A.5, \text{TB DY}) = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu_c, \mu_{cc}) = 0.00553582$$

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

$$\text{From (5.4b), TB DY: } \mu_c = 0.00553582$$

$$\mu_{cc} (5.4c) = 0.00259035$$

$$\omega_{ase} ((5.4d), \text{TB DY}) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

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

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

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

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

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

$$b_k = 300.00$$

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

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

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

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

$$l_o/l_{ou,min} = l_b/l_d = 0.30$$

$$su_1 = 0.4 * su_{1,nominal} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } su_{1,nominal} = 0.08,$$

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

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

$$\text{with } fs_1 = fs = 389.0139$$

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

```

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
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 = 389.0139
with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30
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 = 389.0139
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05813483
2 = Asl,com/(b*d)*(fs2/fc) = 0.05813483
v = Asl,mid/(b*d)*(fsv/fc) = 0.05813483
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07739312
2 = Asl,com/(b*d)*(fs2/fc) = 0.07739312
v = Asl,mid/(b*d)*(fsv/fc) = 0.07739312
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19817337
Mu = MRc (4.14) = 6.6448E+007
u = su (4.1) = 2.4749691E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

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

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

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: $V_c = 88236.482$

= 1 (normal-weight concrete)

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

$\rho_w = A_s/(b_w*d) = 0.00628319$

A_s (tension reinf.) = 603.1858

$b_w = 400.00$

$d = 240.00$

$V_u*d/M_u < 1 = 0.00$

$M_u = 3.4215184E-013$

$V_u = 8.6414578E-021$

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) '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: $V_c = 88236.482$

= 1 (normal-weight concrete)

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

$\rho_w = A_s/(b_w*d) = 0.00628319$

A_s (tension reinf.) = 603.1858

$b_w = 400.00$

$d = 240.00$

$V_u*d/M_u < 1 = 0.00$

$M_u = 3.4215797E-013$

$V_u = 8.6414578E-021$

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, $\phi = 0.90$

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

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$
 Steel Elasticity, $E_s = 200000.00$
 Section Height, $H = 400.00$
 Section Width, $W = 300.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 1850.00$
 Primary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Inadequate Lap Length with $l_b/l_d = 0.30$
 No FRP Wrapping

Stepwise Properties

Bending Moment, $M = -1.1438410E-010$
 Shear Force, $V_2 = -4.6128812E-014$
 Shear Force, $V_3 = -4791.309$
 Axial Force, $F = -618.3078$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{st} = 603.1858$
 -Compression: $A_{sc} = 923.6282$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{st,ten} = 508.938$
 -Compression: $A_{sc,com} = 508.938$
 -Middle: $A_{st,mid} = 508.938$
 Mean Diameter of Tension Reinforcement, $DbL = 14.66667$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.02206661$
 $u = y + p = 0.02206661$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00206661$ ((4.29), Biskinis Phd))
 $M_y = 4.8860E+007$
 $L_s = M/V$ (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 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 8.1958242E-006$
 with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b/l_d)^{2/3}) = 311.2112$
 $d = 258.00$
 $y = 0.26411015$
 $A = 0.01481396$
 $B = 0.00862083$
 with $p_t = 0.00493157$
 $p_c = 0.00493157$
 $p_v = 0.00493157$
 $N = 618.3078$
 $b = 400.00$
 $" = 0.1627907$
 $y_{comp} = 3.2312585E-005$
 with $f_c = 33.00$
 $E_c = 26999.444$
 $y = 0.26390049$

A = 0.01478109
B = 0.00860158
with Es = 200000.00

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

- 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 $V_p/V_o = 0.37228966$

- Transverse Reinforcement: NC

- Stirrup Spacing $> d/3$

- Low ductility demand, $\lambda / y < 2$ (table 10-6, ASCE 41-17)
 $= -7.0790750E-022$

- 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 = $4.6128812E-014$

- ($\rho_t - \rho_c$)/ $\rho_{bal} = -0.18222013$

$= A_{st}/(b_w \times d) = 0.00584482$

Tension Reinf Area: $A_{st} = 603.1858$

$\rho_c = A_{sc}/(b_w \times d) = 0.00894989$

Compression Reinf Area: $A_{sc} = 923.6282$

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): $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + y) = 0.51922877$
 $y = 0.0027778$

- $V/(b_w \times d \times f_c^{0.5}) = 9.3704152E-019$, 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

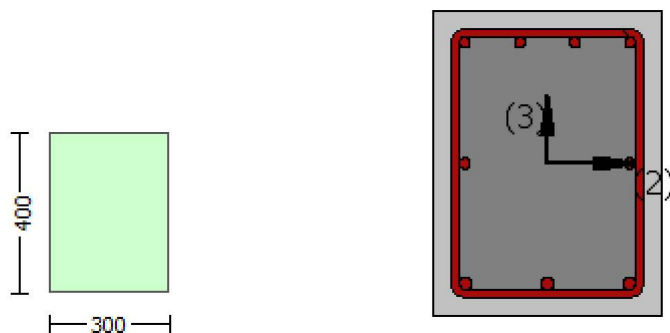
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

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, $\gamma = 0.90$

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

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 1850.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{o,min} = l_b/l_d = 0.30$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = -1.1438410E-010$

Shear Force, $V_a = -4.6128812E-014$

EDGE -B-

Bending Moment, $M_b = 2.9032116E-011$

Shear Force, $V_b = 4.6128812E-014$

BOTH EDGES

Axial Force, $F = -618.3078$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 615.7522$
 -Compression: $As_c = 911.0619$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 508.938$
 -Compression: $As_{c,com} = 508.938$
 -Middle: $As_{mid} = 508.938$
 Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 14.66667$

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

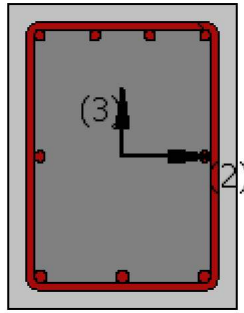
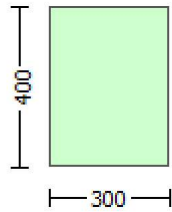
NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

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)
 $\rho_w = As/(b_w \cdot d) = 0.00641409$
 As (tension reinf.) = 615.7522
 $b_w = 400.00$
 $d = 240.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 2.9032116E-011$
 $V_u = 4.6128812E-014$
 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. 14

beam B1, Floor 1
 Limit State: Life Safety (data interpolation between analysis steps 1 and 2)
 Analysis: Uniform +X
 Check: Chord rotation capacity (θ)
 Edge: End
 Local Axis: (2)



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

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcars

Constant Properties

Knowledge Factor, $\phi = 0.90$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

#####

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 = 1.00

Element Length, $L = 1850.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{ou,min} = 0.30$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 2740.264$

EDGE -B-

Shear Force, $V_b = 2740.264$

BOTH EDGES

Axial Force, $F = -189.411$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{sl,t} = 603.1858$

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

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten} = 603.1858$

-Compression: $A_{sl,com} = 615.7522$

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

Calculation of Shear Capacity ratio , $V_e/V_r = 0.39580698$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 112670.646$
 with
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 1.0175E+008$
 $Mu_{1+} = 9.9812E+007$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
 which is defined for the static loading combination
 $Mu_{1-} = 1.0175E+008$, 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
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 1.0162E+008$
 $Mu_{2+} = 9.9934E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
 which is defined for the the static loading combination
 $Mu_{2-} = 1.0162E+008$, 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
 $V_1 = 2740.264$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 2740.264$, 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:

$$\phi_u = 1.7580246E-005$$

$$Mu = 9.9812E+007$$

 with full section properties:

$$b = 300.00$$

$$d = 357.00$$

$$d' = 42.00$$

$$v = 5.3592212E-005$$

$$N = 189.411$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00553582$$

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

$$\text{From (5.4b), TB DY: } \phi_{cu} = 0.00553582$$

$$\phi_{we}(5.4c) = 0.00259035$$

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

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

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

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

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

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

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

$$b_k = 300.00$$

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

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

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

$$b_k = 400.00$$

 $s = 150.00$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

```

ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
    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 = 389.0139
    with Es1 = Es = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
    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 = 389.0139
    with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
    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 = 389.0139
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06639156
2 = Asl,com/(b*d)*(fs2/fc) = 0.06777471
v = Asl,mid/(b*d)*(fsv/fc) = 0.03388736
and confined core properties:
b = 240.00
d = 327.00
d' = 12.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.09060316
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09249072
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04624536
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18421297
Mu = MRc (4.14) = 9.9812E+007

```

$$u = su(4.1) = 1.7580246E-005$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_{u1} -

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

$$\mu_u = 1.7569691E-005$$

$$\mu_u = 1.0175E+008$$

with full section properties:

$$b = 300.00$$

$$d = 358.00$$

$$d' = 43.00$$

$$v = 5.3442513E-005$$

$$N = 189.411$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu_{cu}: \mu_{cu}^* = \text{shear_factor} * \text{Max}(\mu_{cu}, \mu_{cc}) = 0.00553582$$

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

$$\text{From (5.4b), TB DY: } \mu_{cu} = 0.00553582$$

$$\mu_{we}(5.4c) = 0.00259035$$

$$\mu_{ase}((5.4d), \text{TB DY}) = 0.15672608$$

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

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

Expression ((5.4d), TB DY) for $\mu_{psh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

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

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

$$b_k = 300.00$$

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

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

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

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

$$l_o/l_{ou,min} = l_b/l_d = 0.30$$

$$su_1 = 0.4 * su_{1,nominal}((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } su_{1,nominal} = 0.08,$$

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

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

$$\text{with } fs_1 = fs = 389.0139$$

```

with Es1 = Es = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
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 = 389.0139
with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30
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 = 389.0139
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0675854
2 = Asl,com/(b*d)*(fs2/fc) = 0.06620611
v = Asl,mid/(b*d)*(fsv/fc) = 0.0337927
and confined core properties:
b = 240.00
d = 328.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09220874
2 = Asl,com/(b*d)*(fs2/fc) = 0.09032693
v = Asl,mid/(b*d)*(fsv/fc) = 0.04610437
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18600297
Mu = MRc (4.14) = 1.0175E+008
u = su (4.1) = 1.7569691E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

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

$$\phi_u = 1.7539903E-005$$

$$\mu_u = 9.9934E+007$$

with full section properties:

$$b = 300.00$$

$$d = 358.00$$

$$d' = 43.00$$

$$v = 5.3442513E-005$$

$$N = 189.411$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00553582$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00553582$$

$$\phi_{we} (5.4c) = 0.00259035$$

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

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_i^2 = 346400.00$$

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

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

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

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

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

$$b_k = 300.00$$

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

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

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$f_{t1} = 466.8167$$

$$f_{y1} = 389.0139$$

$$su_1 = 0.00512$$

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

$$l_o/l_{ou,min} = l_b/l_d = 0.30$$

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

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

For calculation of $\phi_{su1_nominal}$ and y_1 , sh_1 , f_{t1} , f_{y1} , it is considered
characteristic value $f_{sy1} = f_{s1}/1.2$, from table 5.1, TBDY.

$$y_1, sh_1, f_{t1}, f_{y1}, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b/l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } f_{s1} = f_s = 389.0139$$

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

$$y_2 = 0.00140044$$

$$sh_2 = 0.0044814$$

$$f_{t2} = 466.8167$$

$$f_{y2} = 389.0139$$

$$su_2 = 0.00512$$

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

$$l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$$

$$su_2 = 0.4 * \phi_{su2_nominal} ((5.5), \text{TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } \phi_{su2_nominal} = 0.08,$$

For calculation of $\phi_{su2_nominal}$ and y_2 , sh_2 , f_{t2} , f_{y2} , 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 $fs2 = fs = 389.0139$
 with $Es2 = Es = 200000.00$
 $yv = 0.00140044$
 $shv = 0.0044814$
 $ftv = 466.8167$
 $fyv = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou, min = lb/ld = 0.30$
 $suv = 0.4 \cdot esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 389.0139$
 with $Esv = Es = 200000.00$
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.06620611$
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.0675854$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.0337927$
 and confined core properties:
 $b = 240.00$
 $d = 328.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.09032693$
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.09220874$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.04610437$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < vs, y2$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.18462058$
 $Mu = MRc (4.14) = 9.9934E+007$
 $u = su (4.1) = 1.7539903E-005$

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of $Mu2$ -

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

$u = 1.7610316E-005$
 $Mu = 1.0162E+008$

with full section properties:

$b = 300.00$
 $d = 357.00$
 $d' = 42.00$
 $v = 5.3592212E-005$
 $N = 189.411$
 $fc = 33.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.00553582$

The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.00553582$
 w_e (5.4c) = 0.00259035
 a_{se} ((5.4d), TBDY) = 0.15672608
 $b_o = 240.00$
 $h_o = 340.00$
 $b_{i2} = 346400.00$
 $p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00261799$
 Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $p_{sh,x}$ (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: $c_c = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y_1 = 0.00140044$
 $sh_1 = 0.0044814$
 $ft_1 = 466.8167$
 $fy_1 = 389.0139$
 $su_1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $su_1 = 0.4 * esu1_{nominal}$ ((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 $fs_1 = fs = 389.0139$
 with $Es_1 = Es = 200000.00$
 $y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 466.8167$
 $fy_2 = 389.0139$
 $su_2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$
 $su_2 = 0.4 * esu2_{nominal}$ ((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 $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 389.0139$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $su_v = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$

$suv = 0.4 \cdot esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 389.0139$
 with $Esv = Es = 200000.00$
 $1 = Asl,ten/(b \cdot d) \cdot (fs1/fc) = 0.06777471$
 $2 = Asl,com/(b \cdot d) \cdot (fs2/fc) = 0.06639156$
 $v = Asl,mid/(b \cdot d) \cdot (fsv/fc) = 0.03388736$
 and confined core properties:
 $b = 240.00$
 $d = 327.00$
 $d' = 12.00$
 $fcc (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl,ten/(b \cdot d) \cdot (fs1/fc) = 0.09249072$
 $2 = Asl,com/(b \cdot d) \cdot (fs2/fc) = 0.09060316$
 $v = Asl,mid/(b \cdot d) \cdot (fsv/fc) = 0.04624536$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied
 ---->
 $su (4.9) = 0.18560594$
 $Mu = MRc (4.14) = 1.0162E+008$
 $u = su (4.1) = 1.7610316E-005$

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Shear Strength $Vr = \text{Min}(Vr1, Vr2) = 284660.584$

Calculation of Shear Strength at edge 1, $Vr1 = 284660.584$
 $Vr1 = Vn ((22.5.1.1), ACI 318-14)$

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: $Vc = 98490.641$
 $= 1$ (normal-weight concrete)
 $fc' = 33.00$, but $fc^{0.5} \leq 8.3 \text{ MPa}$ (22.5.3.1, ACI 318-14)
 $pw = As/(bw \cdot d) = 0.00628319$
 As (tension reinf.) = 603.1858
 $bw = 300.00$
 $d = 320.00$
 $Vu \cdot d / Mu < 1 = 1.00$
 $Mu = 69262.055$
 $Vu = 2740.264$

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, $Vr2 = 284660.584$
 $Vr2 = Vn ((22.5.1.1), ACI 318-14)$

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

From Table (22.5.5.1), ACI 318-14: $V_c = 98490.641$
= 1 (normal-weight concrete)

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

$\rho_w = A_s/(b_w*d) = 0.00628319$

A_s (tension reinf.) = 603.1858

$b_w = 300.00$

$d = 320.00$

$V_u*d/M_u < 1 = 1.00$

$M_u = 69262.055$

$V_u = 2740.264$

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, $\phi = 0.90$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

#####

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 = 1.00

Element Length, $L = 1850.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{ou,min} = 0.30$

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = -8.6414578E-021$

EDGE -B-

Shear Force, $V_b = 8.6414578E-021$

BOTH EDGES

Axial Force, $F = -189.411$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 603.1858$

-Compression: $As_c = 923.6282$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 508.938$

-Compression: $As_{c,com} = 508.938$

-Middle: $As_{mid} = 508.938$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.37228966$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 71835.924$ with

$M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 6.6448E+007$

$Mu_{1+} = 6.6448E+007$, 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

$Mu_{1-} = 6.6448E+007$, 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

$M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 6.6448E+007$

$Mu_{2+} = 6.6448E+007$, 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

$Mu_{2-} = 6.6448E+007$, 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

$V_1 = -8.6414578E-021$, is the shear force acting at edge 1 for the static loading combination

$V_2 = 8.6414578E-021$, 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:

$\phi_u = 2.4749691E-005$

$M_u = 6.6448E+007$

with full section properties:

$b = 400.00$

$d = 258.00$

$d' = 42.00$

$v = 5.5617499E-005$

$N = 189.411$

$f_c = 33.00$

ϕ_c (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00553582$

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

From (5.4b), TBDY: $\phi_u = 0.00553582$

w_e (5.4c) = 0.00259035

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

$b_o = 240.00$

$h_o = 340.00$

$bi_2 = 346400.00$

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

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

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

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

No stirrups, $n_s = 2.00$

$b_k = 300.00$

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 = 0.002
 c = confinement factor = 1.00

y1 = 0.00140044
 sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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 = 389.0139

with Es1 = Es = 200000.00

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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 = 389.0139

with Es2 = Es = 200000.00

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30

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 = 389.0139

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.05813483

2 = Asl,com/(b*d)*(fs2/fc) = 0.05813483

v = Asl,mid/(b*d)*(fsv/fc) = 0.05813483

and confined core properties:

b = 340.00

d = 228.00

d' = 12.00

fcc (5A.2, TBDY) = 33.00

```

cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07739312
2 = Asl,com/(b*d)*(fs2/fc) = 0.07739312
v = Asl,mid/(b*d)*(fsv/fc) = 0.07739312
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19817337
Mu = MRc (4.14) = 6.6448E+007
u = su (4.1) = 2.4749691E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

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

```

u = 2.4749691E-005
Mu = 6.6448E+007

```

with full section properties:

```

b = 400.00
d = 258.00
d' = 42.00
v = 5.5617499E-005
N = 189.411
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00553582
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00553582
we (5.4c) = 0.00259035
ase ((5.4d), TBDY) = 0.15672608
bo = 240.00
ho = 340.00
bi2 = 346400.00
psh,min = Min(psh,x , psh,y) = 0.00261799
Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

```

```

psh,x (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 = 0.002
c = confinement factor = 1.00
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167

```



```

fy1 = 389.0139
su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 0.30
    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 = 389.0139
    with Es1 = Es = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
    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 = 389.0139
    with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 0.30
    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 = 389.0139
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05813483
2 = Asl,com/(b*d)*(fs2/fc) = 0.05813483
v = Asl,mid/(b*d)*(fsv/fc) = 0.05813483
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07739312
2 = Asl,com/(b*d)*(fs2/fc) = 0.07739312
v = Asl,mid/(b*d)*(fsv/fc) = 0.07739312
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19817337
Mu = MRc (4.14) = 6.6448E+007
u = su (4.1) = 2.4749691E-005

```

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_{2+}

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

$$\mu = 2.4749691E-005$$

$$\mu = 6.6448E+007$$

with full section properties:

$$b = 400.00$$

$$d = 258.00$$

$$d' = 42.00$$

$$v = 5.5617499E-005$$

$$N = 189.411$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu, \omega) = 0.00553582$$

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

$$\text{From (5.4b), TB DY: } \mu = 0.00553582$$

$$\omega (5.4c) = 0.00259035$$

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

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_i^2 = 346400.00$$

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

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

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

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

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

$$b_k = 300.00$$

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

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

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

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

$$l_o/l_{o,min} = l_b/l_d = 0.30$$

$$su_1 = 0.4 * su_{1,nominal} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } su_{1,nominal} = 0.08,$$

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

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

$$\text{with } fs_1 = fs = 389.0139$$

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

```

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
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 = 389.0139
with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.30
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 = 389.0139
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05813483
2 = Asl,com/(b*d)*(fs2/fc) = 0.05813483
v = Asl,mid/(b*d)*(fsv/fc) = 0.05813483
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07739312
2 = Asl,com/(b*d)*(fs2/fc) = 0.07739312
v = Asl,mid/(b*d)*(fsv/fc) = 0.07739312
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19817337
Mu = MRc (4.14) = 6.6448E+007
u = su (4.1) = 2.4749691E-005

```

Calculation of ratio lb/lb

Inadequate Lap Length with lb/lb = 0.30

Calculation of Mu2-

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

u = 2.4749691E-005
Mu = 6.6448E+007

with full section properties:

b = 400.00
d = 258.00
d' = 42.00
v = 5.5617499E-005
N = 189.411

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu: $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00553582$

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

From (5.4b), TBDY: $cu = 0.00553582$

we (5.4c) = 0.00259035

ase ((5.4d), TBDY) = 0.15672608

bo = 240.00

ho = 340.00

bi2 = 346400.00

psh,min = Min(psh,x , psh,y) = 0.00261799

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

psh,x (5.4d) = 0.00349066

Ash = Astir*ns = 78.53982

No stirrups, ns = 2.00

bk = 300.00

psh,y (5.4d) = 0.00261799

Ash = Astir*ns = 78.53982

No stirrups, ns = 2.00

bk = 400.00

s = 150.00

fywe = 694.45

fce = 33.00

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

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

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

lo/lou,min = lb/lb = 0.30

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

with $fs1 = fs = 389.0139$

with $Es1 = Es = 200000.00$

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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

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

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

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 389.0139$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/d = 0.30$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 389.0139$
 with $Es_v = Es = 200000.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (fs_1/f_c) = 0.05813483$
 $2 = A_{sl,com}/(b \cdot d) \cdot (fs_2/f_c) = 0.05813483$
 $v = A_{sl,mid}/(b \cdot d) \cdot (fsv/f_c) = 0.05813483$
 and confined core properties:

$b = 340.00$
 $d = 228.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (fs_1/f_c) = 0.07739312$
 $2 = A_{sl,com}/(b \cdot d) \cdot (fs_2/f_c) = 0.07739312$
 $v = A_{sl,mid}/(b \cdot d) \cdot (fsv/f_c) = 0.07739312$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

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

$su (4.9) = 0.19817337$
 $Mu = MRc (4.14) = 6.6448E+007$
 $u = su (4.1) = 2.4749691E-005$

 Calculation of ratio l_b/d

 Inadequate Lap Length with $l_b/d = 0.30$

 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 $f'_c^{0.5} \leq 8.3 \text{ MPa}$ (22.5.3.1, ACI 318-14)
 $pw = A_s/(b_w \cdot d) = 0.00628319$
 A_s (tension reinf.) = 603.1858
 $b_w = 400.00$
 $d = 240.00$
 $V_u \cdot d / Mu < 1 = 0.00$
 $Mu = 3.4215184E-013$

$$V_u = 8.6414578E-021$$

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)

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

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

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

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)

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

$$p_w = A_s / (b_w \cdot d) = 0.00628319$$

$$A_s (\text{tension reinf.}) = 603.1858$$

$$b_w = 400.00$$

$$d = 240.00$$

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

$$M_u = 3.4215797E-013$$

$$V_u = 8.6414578E-021$$

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: (b)

Section Type: rcars

Constant Properties

Knowledge Factor, = 0.90

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

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 1850.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_b / l_d = 0.30$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 7.0292\text{E}+006$

Shear Force, $V2 = 4.6128812\text{E}-014$

Shear Force, $V3 = 10271.838$

Axial Force, $F = -618.3078$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 615.7522$

-Compression: $As_c = 911.0619$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 615.7522$

-Compression: $As_{c,com} = 603.1858$

-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 $u_R = 1.0^*$ $u = 0.02126874$

$u = y + p = 0.02126874$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00126874$ ((4.29), Biskinis Phd))

$M_y = 7.2083\text{E}+007$

$L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 684.3158

From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 1.2960\text{E}+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

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

$y_{ten} = 5.8363338\text{E}-006$

with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (I_b / I_d)^{2/3}) = 311.2112$

$d = 358.00$

$y = 0.25526458$

$A = 0.01423464$

$B = 0.00803181$

with $p_t = 0.00573326$

$p_c = 0.00561626$

$p_v = 0.00286663$

$N = 618.3078$

$b = 300.00$

$" = 0.12011173$

$y_{comp} = 2.4094792\text{E}-005$

with $f_c = 33.00$

$E_c = 26999.444$

$y = 0.25505004$

$A = 0.01420306$

$B = 0.00801331$

with $E_s = 200000.00$

Calculation of ratio I_b / I_d

Inadequate Lap Length with $I_b / I_d = 0.30$

- 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 $V_p/V_o = 0.39580698$
- Transverse Reinforcement: NC
- Stirrup Spacing $> d/3$
- Low ductility demand, $\lambda / y < 2$ (table 10-6, ASCE 41-17)
 $= 2.9053636E-005$
- 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 = 10271.838
- ($\lambda - \lambda'$)/ bal = -0.16136132
 $= A_{sl}/(b_w \times d) = 0.00573326$
Tension Reinf Area: $A_{sl} = 615.7522$
 $\lambda' = A_{slc}/(b_w \times d) = 0.00848289$
Compression Reinf Area: $A_{slc} = 911.0619$
- 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): $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + y) = 0.51922877$
 $y = 0.0027778$
- $V/(b_w \times d \times f_c^{0.5}) = 0.20049804$, 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

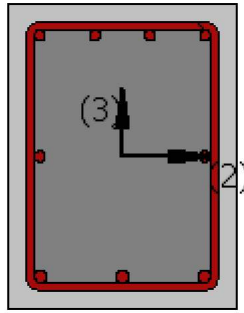
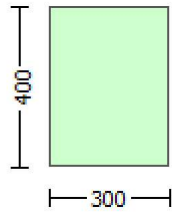
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

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, $\phi = 0.90$

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

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 1850.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{o,min} = l_b/l_d = 0.30$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 6.9042E+006$

Shear Force, $V_a = -4791.309$

EDGE -B-

Bending Moment, $M_b = 7.0292E+006$

Shear Force, $V_b = 10271.838$

BOTH EDGES

Axial Force, $F = -618.3078$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_{lt} = 615.7522$

-Compression: $As_{lc} = 911.0619$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{l,ten} = 615.7522$

-Compression: $As_{l,com} = 603.1858$

-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 $VR = 1.0 \cdot V_n = 249246.558$

V_n ((22.5.1.1), ACI 318-14) = 249246.558

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: $V_c = 81694.95$

= 1 (normal-weight concrete)

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

$\rho_w = A_s/(b_w*d) = 0.00641409$

A_s (tension reinf.) = 615.7522

$b_w = 300.00$

$d = 320.00$

$V_u*d/M_u < 1 = 0.46762033$

$M_u = 7.0292E+006$

$V_u = 10271.838$

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 ($s \leq d/2$, according to ASCE 41-17, 10.3.4)

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

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

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

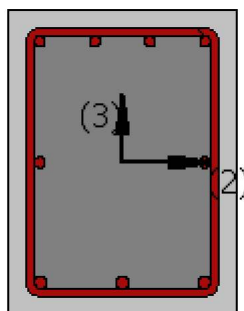
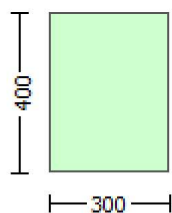
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

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, $\phi = 0.90$

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

#####

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 = 1.00

Element Length, $L = 1850.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{ou,min} = 0.30$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 2740.264$

EDGE -B-

Shear Force, $V_b = 2740.264$

BOTH EDGES

Axial Force, $F = -189.411$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{sl,t} = 603.1858$

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

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten} = 603.1858$

-Compression: $A_{sl,com} = 615.7522$

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

Calculation of Shear Capacity ratio, $V_e/V_r = 0.39580698$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 112670.646$
with

$M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 1.0175E+008$

$\mu_{u1+} = 9.9812E+007$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$\mu_{u1-} = 1.0175E+008$, 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

$M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 1.0162E+008$

$\mu_{u2+} = 9.9934E+007$, 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

$\mu_{u2-} = 1.0162E+008$, 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 = 2740.264, is the shear force acting at edge 1 for the the static loading combination
V2 = 2740.264, 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:

$$\phi_u = 1.7580246E-005$$

$$M_u = 9.9812E+007$$

with full section properties:

$$b = 300.00$$

$$d = 357.00$$

$$d' = 42.00$$

$$\nu = 5.3592212E-005$$

$$N = 189.411$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{co}) = 0.00553582$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00553582$$

$$\phi_{we} (5.4c) = 0.00259035$$

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

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

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

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

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

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

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

$$b_k = 300.00$$

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

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

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$f_{t1} = 466.8167$$

$$f_{y1} = 389.0139$$

$$s_{u1} = 0.00512$$

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

$$l_o/l_{ou,min} = l_b/l_d = 0.30$$

$$s_{u1} = 0.4 * s_{u1,nominal} ((5.5), TBDY) = 0.032$$

$$\text{From table 5A.1, TBDY: } s_{u1,nominal} = 0.08,$$

For calculation of $s_{u1,nominal}$ 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.

$$\text{with } f_{s1} = f_s = 389.0139$$

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

$$y_2 = 0.00140044$$

$$sh_2 = 0.0044814$$

$$f_{t2} = 466.8167$$

$$f_{y2} = 389.0139$$

```

su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
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 = 389.0139
with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30
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 = 389.0139
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06639156
2 = Asl,com/(b*d)*(fs2/fc) = 0.06777471
v = Asl,mid/(b*d)*(fsv/fc) = 0.03388736
and confined core properties:
b = 240.00
d = 327.00
d' = 12.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09060316
2 = Asl,com/(b*d)*(fs2/fc) = 0.09249072
v = Asl,mid/(b*d)*(fsv/fc) = 0.04624536
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18421297
Mu = MRc (4.14) = 9.9812E+007
u = su (4.1) = 1.7580246E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

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

u = 1.7569691E-005

Mu = 1.0175E+008

with full section properties:

$b = 300.00$
 $d = 358.00$
 $d' = 43.00$
 $v = 5.3442513E-005$
 $N = 189.411$
 $f_c = 33.00$
 $\phi (5A.5, TBDY) = 0.002$
 Final value of ϕ : $\phi^* = \text{shear_factor} * \text{Max}(\phi_c, \phi_s) = 0.00553582$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\phi_c = 0.00553582$
 $\phi_s (5.4c) = 0.00259035$
 $\phi_{se} ((5.4d), TBDY) = 0.15672608$
 $b_o = 240.00$
 $h_o = 340.00$
 $b_i^2 = 346400.00$
 $\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00261799$
 Expression ((5.4d), TBDY) for $\phi_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$\phi_{sh,x} (5.4d) = 0.00349066$
 $A_{sh} = A_{stir} * n_s = 78.53982$
 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 ((5A.5), TBDY), TBDY: $\phi_c = 0.002$
 $\phi_c = \text{confinement factor} = 1.00$
 $y_1 = 0.00140044$
 $sh_1 = 0.0044814$
 $ft_1 = 466.8167$
 $fy_1 = 389.0139$
 $su_1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $su_1 = 0.4 * \phi_{su1_nominal} ((5.5), TBDY) = 0.032$
 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 $\phi_{sy1} = \phi_s / 1.2$, 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 $\phi_s = \phi_s = 389.0139$
 with $E_{s1} = E_s = 200000.00$
 $y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 466.8167$
 $fy_2 = 389.0139$
 $su_2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$
 $su_2 = 0.4 * \phi_{su2_nominal} ((5.5), TBDY) = 0.032$
 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 $\phi_{sy2} = \phi_s / 1.2$, 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 $\phi_s = \phi_s = 389.0139$
 with $E_{s2} = E_s = 200000.00$
 $y_v = 0.00140044$

```

shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (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 = 0.30
    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 = 389.0139
    with Esv = Es = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.0675854
    2 = Asl,com/(b*d)*(fs2/fc) = 0.06620611
    v = Asl,mid/(b*d)*(fsv/fc) = 0.0337927
and confined core properties:
b = 240.00
d = 328.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.09220874
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09032693
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04610437
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18600297
Mu = MRc (4.14) = 1.0175E+008
u = su (4.1) = 1.7569691E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

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

```

u = 1.7539903E-005
Mu = 9.9934E+007

```

with full section properties:

```

b = 300.00
d = 358.00
d' = 43.00
v = 5.3442513E-005
N = 189.411
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00553582
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00553582
we (5.4c) = 0.00259035
ase ((5.4d), TBDY) = 0.15672608
bo = 240.00

```

$h_o = 340.00$
 $bi2 = 346400.00$
 $psh,min = \text{Min}(psh,x, psh,y) = 0.00261799$
 Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

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

$s = 150.00$
 $fywe = 694.45$
 $fce = 33.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 466.8167$
 $fy1 = 389.0139$
 $su1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00
 $lo/lou,min = lb/ld = 0.30$
 $su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu1_nominal = 0.08$,
 For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered characteristic value $fsy1 = fs/1.2$, 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 $fs1 = fs = 389.0139$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 466.8167$
 $fy2 = 389.0139$
 $su2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00
 $lo/lou,min = lb/lb,min = 0.30$
 $su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered characteristic value $fsy2 = fs/1.2$, 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 $fs2 = fs = 389.0139$
 with $Es2 = Es = 200000.00$
 $yv = 0.00140044$
 $shv = 0.0044814$
 $ftv = 466.8167$
 $fyv = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00
 $lo/lou,min = lb/ld = 0.30$
 $suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032$
 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 $fsv = fs = 389.0139$
 with $Esv = Es = 200000.00$
 $1 = Asl,ten/(b \cdot d) \cdot (fs1/fc) = 0.06620611$
 $2 = Asl,com/(b \cdot d) \cdot (fs2/fc) = 0.0675854$
 $v = Asl,mid/(b \cdot d) \cdot (fsv/fc) = 0.0337927$
 and confined core properties:
 $b = 240.00$
 $d = 328.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl,ten/(b \cdot d) \cdot (fs1/fc) = 0.09032693$
 $2 = Asl,com/(b \cdot d) \cdot (fs2/fc) = 0.09220874$
 $v = Asl,mid/(b \cdot d) \cdot (fsv/fc) = 0.04610437$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.18462058$
 $Mu = MRc (4.14) = 9.9934E+007$
 $u = su (4.1) = 1.7539903E-005$

 Calculation of ratio lb/d

 Inadequate Lap Length with $lb/d = 0.30$

 Calculation of $Mu2$ -

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.7610316E-005$
 $Mu = 1.0162E+008$

 with full section properties:
 $b = 300.00$
 $d = 357.00$
 $d' = 42.00$
 $v = 5.3592212E-005$
 $N = 189.411$
 $fc = 33.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.00553582$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.00553582$
 $we (5.4c) = 0.00259035$
 $ase ((5.4d), TBDY) = 0.15672608$
 $bo = 240.00$
 $ho = 340.00$
 $bi2 = 346400.00$
 $psh,min = \text{Min}(psh,x, psh,y) = 0.00261799$
 Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without
 earthquake detailing (90° closed stirrups)

 $psh,x (5.4d) = 0.00349066$
 $Ash = Astir \cdot ns = 78.53982$
 No stirrups, $ns = 2.00$
 $bk = 300.00$

 $psh,y (5.4d) = 0.00261799$
 $Ash = Astir \cdot ns = 78.53982$

No stirrups, ns = 2.00
bk = 400.00

s = 150.00
fywe = 694.45
fce = 33.00

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

y1 = 0.00140044
sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

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

lo/lou,min = lb/lb = 0.30

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 = 389.0139

with Es1 = Es = 200000.00

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30

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 = 389.0139

with Es2 = Es = 200000.00

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

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

lo/lou,min = lb/lb = 0.30

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 = 389.0139

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.06777471

2 = Asl,com/(b*d)*(fs2/fc) = 0.06639156

v = Asl,mid/(b*d)*(fsv/fc) = 0.03388736

and confined core properties:

b = 240.00

d = 327.00

d' = 12.00

fcc (5A.2, TBDY) = 33.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.09249072$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.09060316$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.04624536$$

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

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

--->
 $\mu_u(4.9) = 0.18560594$
 $\mu_u = M_{Rc}(4.14) = 1.0162E+008$
 $u = \mu_u(4.1) = 1.7610316E-005$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 284660.584$

Calculation of Shear Strength at edge 1, $V_{r1} = 284660.584$
 $V_{r1} = V_n((22.5.1.1), \text{ACI 318-14})$

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

From Table (22.5.5.1), ACI 318-14: $V_c = 98490.641$
 $= 1$ (normal-weight concrete)
 $f'_c = 33.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s/(b_w*d) = 0.00628319$
 A_s (tension reinf.) = 603.1858
 $b_w = 300.00$
 $d = 320.00$
 $V_u*d/\mu_u < 1 = 1.00$
 $\mu_u = 69262.055$
 $V_u = 2740.264$

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, $V_{r2} = 284660.584$
 $V_{r2} = V_n((22.5.1.1), \text{ACI 318-14})$

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: $V_c = 98490.641$
 $= 1$ (normal-weight concrete)
 $f'_c = 33.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s/(b_w*d) = 0.00628319$
 A_s (tension reinf.) = 603.1858
 $b_w = 300.00$
 $d = 320.00$
 $V_u*d/\mu_u < 1 = 1.00$
 $\mu_u = 69262.055$
 $V_u = 2740.264$

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)

Vf ((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, $\phi = 0.90$
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 555.56$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$

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 = 1.00
Element Length, $L = 1850.00$
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with $l_o/l_{o,min} = 0.30$
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = -8.6414578E-021$
EDGE -B-
Shear Force, $V_b = 8.6414578E-021$
BOTH EDGES
Axial Force, $F = -189.411$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 603.1858$
-Compression: $A_{sc} = 923.6282$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten} = 508.938$
-Compression: $A_{st,com} = 508.938$
-Middle: $A_{st,mid} = 508.938$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.37228966$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 71835.924$
with
 $M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 6.6448E+007$

Mu1+ = 6.6448E+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

Mu1- = 6.6448E+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

Mpr2 = Max(Mu2+ , Mu2-) = 6.6448E+007

Mu2+ = 6.6448E+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

Mu2- = 6.6448E+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

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

with

V1 = -8.6414578E-021, is the shear force acting at edge 1 for the the static loading combination

V2 = 8.6414578E-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:

$\phi_u = 2.4749691E-005$

$M_u = 6.6448E+007$

with full section properties:

b = 400.00

d = 258.00

d' = 42.00

$v = 5.5617499E-005$

N = 189.411

$f_c = 33.00$

ϕ_c (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.00553582$

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

From (5.4b), TBDY: $\phi_u = 0.00553582$

ϕ_{ue} (5.4c) = 0.00259035

ϕ_{ase} ((5.4d), TBDY) = 0.15672608

$b_o = 240.00$

$h_o = 340.00$

$b_{i2} = 346400.00$

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

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

 $\phi_{sh,x}$ (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), TBDY), TBDY: $\phi_c = 0.002$

c = confinement factor = 1.00

$y_1 = 0.00140044$

$sh_1 = 0.0044814$

$ft_1 = 466.8167$

$fy_1 = 389.0139$

$su_1 = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30
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 = 389.0139
with Es1 = Es = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
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 = 389.0139
with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.30
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 = 389.0139
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05813483
2 = Asl,com/(b*d)*(fs2/fc) = 0.05813483
v = Asl,mid/(b*d)*(fsv/fc) = 0.05813483
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07739312
2 = Asl,com/(b*d)*(fs2/fc) = 0.07739312
v = Asl,mid/(b*d)*(fsv/fc) = 0.07739312
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
---->
v < vs,y2 - LHS eq.(4.5) is satisfied
---->
su (4.9) = 0.19817337
Mu = MRc (4.14) = 6.6448E+007
u = su (4.1) = 2.4749691E-005

```

Calculation of ratio lb/d

Inadequate Lap Length with lb/d = 0.30

Calculation of Mu1-

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

$$\phi_u = 2.4749691E-005$$

$$M_u = 6.6448E+007$$

with full section properties:

$$b = 400.00$$

$$d = 258.00$$

$$d' = 42.00$$

$$\nu = 5.5617499E-005$$

$$N = 189.411$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_c) = 0.00553582$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00553582$$

$$\phi_{we} \text{ (5.4c)} = 0.00259035$$

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

$$b_o = 240.00$$

$$h_o = 340.00$$

$$b_{i2} = 346400.00$$

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

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

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

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

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

$$b_k = 300.00$$

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

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

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

$$b_k = 400.00$$

$$s = 150.00$$

$$f_{ywe} = 694.45$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 466.8167$$

$$fy_1 = 389.0139$$

$$su_1 = 0.00512$$

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

$$l_o/l_{ou,min} = l_b/l_d = 0.30$$

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

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

For calculation of $\phi_{su1_nominal}$ and y_1, sh_1, 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.

$$\text{with } fs_1 = fs = 389.0139$$

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

$$y_2 = 0.00140044$$

$$sh_2 = 0.0044814$$

$$ft_2 = 466.8167$$

$$fy_2 = 389.0139$$

$$su_2 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 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 $fs_2 = fs = 389.0139$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 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 $fsv = fs = 389.0139$
 with $Es_v = Es = 200000.00$
 $1 = Asl_{ten}/(b*d) * (fs_1/f_c) = 0.05813483$
 $2 = Asl_{com}/(b*d) * (fs_2/f_c) = 0.05813483$
 $v = Asl_{mid}/(b*d) * (fsv/f_c) = 0.05813483$
 and confined core properties:
 $b = 340.00$
 $d = 228.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_{ten}/(b*d) * (fs_1/f_c) = 0.07739312$
 $2 = Asl_{com}/(b*d) * (fs_2/f_c) = 0.07739312$
 $v = Asl_{mid}/(b*d) * (fsv/f_c) = 0.07739312$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.19817337$
 $Mu = MRc (4.14) = 6.6448E+007$
 $u = su (4.1) = 2.4749691E-005$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Mu_{2+}

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

$$u = 2.4749691E-005$$

$$Mu = 6.6448E+007$$

with full section properties:

$$b = 400.00$$

$d = 258.00$
 $d' = 42.00$
 $v = 5.5617499E-005$
 $N = 189.411$
 $f_c = 33.00$
 $\phi (5A.5, TBDY) = 0.002$
 Final value of ϕ : $\phi^* = \text{shear_factor} * \text{Max}(\phi, \phi_c) = 0.00553582$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\phi = 0.00553582$
 $\phi_w (5.4c) = 0.00259035$
 $\phi_{se} ((5.4d), TBDY) = 0.15672608$
 $b_o = 240.00$
 $h_o = 340.00$
 $b_{i2} = 346400.00$
 $\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00261799$
 Expression ((5.4d), TBDY) for $\phi_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$\phi_{sh,x} (5.4d) = 0.00349066$
 $A_{sh} = A_{stir} * n_s = 78.53982$
 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), TBDY), TBDY: $\phi_c = 0.002$
 $\phi_c = \text{confinement factor} = 1.00$
 $y_1 = 0.00140044$
 $sh_1 = 0.0044814$
 $ft_1 = 466.8167$
 $fy_1 = 389.0139$
 $su_1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $su_1 = 0.4 * esu1_{nominal} ((5.5), TBDY) = 0.032$
 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 $fs_1 = fs = 389.0139$
 with $Es_1 = Es = 200000.00$
 $y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 466.8167$
 $fy_2 = 389.0139$
 $su_2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$
 $su_2 = 0.4 * esu2_{nominal} ((5.5), TBDY) = 0.032$
 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 $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = fs = 389.0139$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$

```

ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (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 = 0.30
    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 = 389.0139
    with Esv = Es = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.05813483
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05813483
    v = Asl,mid/(b*d)*(fsv/fc) = 0.05813483
and confined core properties:
b = 340.00
d = 228.00
d' = 12.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.07739312
    2 = Asl,com/(b*d)*(fs2/fc) = 0.07739312
    v = Asl,mid/(b*d)*(fsv/fc) = 0.07739312
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19817337
Mu = MRc (4.14) = 6.6448E+007
u = su (4.1) = 2.4749691E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

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

u = 2.4749691E-005

Mu = 6.6448E+007

with full section properties:

b = 400.00

d = 258.00

d' = 42.00

v = 5.5617499E-005

N = 189.411

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00553582

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

From (5.4b), TBDY: cu = 0.00553582

we (5.4c) = 0.00259035

ase ((5.4d), TBDY) = 0.15672608

bo = 240.00

ho = 340.00

```

bi2 = 346400.00
psh,min = Min(psh,x , psh,y) = 0.00261799
Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
-----
psh,x (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 = 0.002
c = confinement factor = 1.00
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
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 = 389.0139
with Es1 = Es = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
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 = 389.0139
with Es2 = Es = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_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 = 0.30
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 $f_{sv} = f_s = 389.0139$
 with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.05813483$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.05813483$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05813483$
 and confined core properties:
 $b = 340.00$
 $d = 228.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.07739312$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.07739312$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.07739312$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.19817337$
 $Mu = MRc (4.14) = 6.6448E+007$
 $u = su (4.1) = 2.4749691E-005$

Calculation of ratio l_b/d

Inadequate Lap Length with $l_b/d = 0.30$

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

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

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: $V_c = 88236.482$
 $= 1$ (normal-weight concrete)
 $f_c' = 33.00$, but $f_c'^{0.5} \leq 8.3 \text{ MPa}$ (22.5.3.1, ACI 318-14)
 $p_w = A_s/(b_w*d) = 0.00628319$
 A_s (tension reinf.) = 603.1858
 $b_w = 400.00$
 $d = 240.00$
 $V_u*d/Mu < 1 = 0.00$
 $Mu = 3.4215184E-013$
 $V_u = 8.6414578E-021$
 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 ' $V_w + f*V_f$ '
 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)

$\rho_w = A_s/(b_w \cdot d) = 0.00628319$

A_s (tension reinf.) = 603.1858

$b_w = 400.00$

$d = 240.00$

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

$M_u = 3.4215797E-013$

$V_u = 8.6414578E-021$

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, $\gamma = 0.90$

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

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

Consequently:

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

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

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Section Height, $H = 400.00$

Section Width, $W = 300.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 1850.00$

Primary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_b/l_d = 0.30$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 2.9032116E-011$

Shear Force, $V_2 = 4.6128812E-014$

Shear Force, $V_3 = 10271.838$

Axial Force, $F = -618.3078$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 615.7522$

-Compression: $A_{sc} = 911.0619$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{st,ten} = 508.938$

-Compression: $A_{sc,com} = 508.938$

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

Mean Diameter of Tension Reinforcement, $Db_L = 14.66667$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.02206661$
 $u = y + p = 0.02206661$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00206661$ ((4.29), Biskinis Phd))
 $M_y = 4.8860E+007$
 $L_s = M/V$ (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 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 8.1958242E-006$
with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (I_b / I_d)^{2/3}) = 311.2112$
 $d = 258.00$
 $y = 0.26411015$
 $A = 0.01481396$
 $B = 0.00862083$
with $p_t = 0.00493157$
 $p_c = 0.00493157$
 $p_v = 0.00493157$
 $N = 618.3078$
 $b = 400.00$
 $" = 0.1627907$
 $y_{comp} = 3.2312585E-005$
with $f_c = 33.00$
 $E_c = 26999.444$
 $y = 0.26390049$
 $A = 0.01478109$
 $B = 0.00860158$
with $E_s = 200000.00$

Calculation of ratio I_b / I_d

Inadequate Lap Length with $I_b / I_d = 0.30$

- 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 $V_p / V_o = 0.37228966$
- Transverse Reinforcement: NC
- Stirrup Spacing $> d/3$
- Low ductility demand, $\phi / y < 2$ (table 10-6, ASCE 41-17)
 $= -1.0067817E-021$
- Stirrup Spacing $> d/2$
 $d = 258.00$
 $s = 150.00$
- Strength provided by hoops $V_s < 3/4 * \text{design Shear}$
 $V_s = 139627.457$, already given in calculation of shear control ratio
design Shear = $4.6128812E-014$

- (- ')/ bal = -0.16792835
 = Aslt/(bw*d) = 0.00596659
 Tension Reinf Area: Aslt = 615.7522
 ' = Aslc/(bw*d) = 0.00882812
 Compression Reinf Area: Aslc = 911.0619
 From (B-1), ACI 318-11: bal = 0.01704017
 fc = 33.00
 fy = 555.56
 From 10.2.7.3, ACI 318-11: 1 = 0.65
 From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000/(87000 + fy) = cb/dt = 0.003/(0.003 + y) = 0.51922877$
 y = 0.0027778
 - $V/(bw*d*fc^{0.5}) = 9.3704152E-019$, NOTE: units in lb & in
 bw = 400.00

 End Of Calculation of Chord Rotation Capacity for element: beam B1 of floor 1
 At local axis: 3
 Integration Section: (b)