Detailed Member Calculations

Units: N&mm

Regulation: ASCE 41-17

Calculation No. 1

column C1, Floor 1

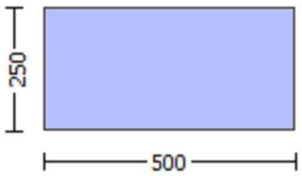
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

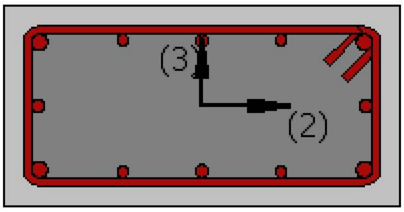
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)





Start Of Calculation of Shear Capacity for element: column C1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
##
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -1.3676E+007
Shear Force, Va = -4557.939
EDGE -B-
Bending Moment, Mb = 0.01695584
Shear Force, Vb = 4557.939
BOTH EDGES
Axial Force, F = -4714.984
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL,ten = 18.66667

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 376907.476
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 376907.476
VCol = 376907.476
knl = 1.00
displacement_ductility_demand = 0.03078504

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
Mu = 1.3676E+007
Vu = 4557.939
d = 0.8*h = 400.00
Nu = 4714.984
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 314159.265
Av = 157079.633
fy = 500.00
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: Vs + Vf <= 332151.915
bw = 250.00

----
displacement_ductility_demand is calculated as θ/θy

- Calculation of θ/θy for END A -
for rotation axis 3 and integ. section (a)

From analysis, chord rotation θ = 0.00017806
θy = (My*Ls/3)/EIeff = 0.00578405 ((4.29),Biskinis Phd))
My = 1.2198E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3000.549
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.1093E+013
factor = 0.30
Ag = 125000.00
fc' = 33.00
N = 4714.984
Ec*Ig = 7.0311E+013

Calculation of Yielding Moment My

Calculation of Φy and My according to Annex 7A - KΑΝΕΠΕ

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0836281E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 262.3043
d = 457.00
ξy = 0.29723032
A = 0.02358523
B = 0.01297347
with pt = 0.00725935
pc = 0.00725935
pv = 0.0089092
N = 4714.984
b = 250.00
δ'' = 0.0940919
Φy_comp = 1.6267960E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29592545
A = 0.0233341
B = 0.01281613
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.2321382
lb = 300.00
ld = 1292.334
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796

where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

End Of Calculation of Shear Capacity for element: column C1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 2

column C1, Floor 1

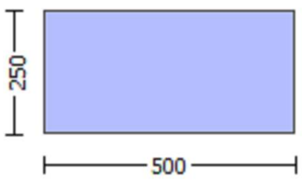
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

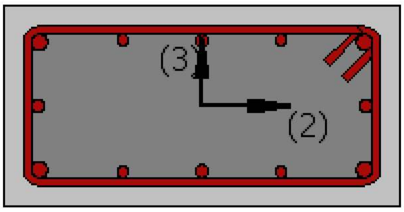
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (2)





Start Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
Section Height, H = 250.00

Section Width, W = 500.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03851
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -6.3058752E-032
EDGE -B-
Shear Force, Vb = 6.3058752E-032
BOTH EDGES
Axial Force, F = -4716.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.14541623
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 46326.653
with
Mpr1 = Max(Mu1+ , Mu1-) = 6.9490E+007
Mu1+ = 6.9490E+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- = 6.9490E+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-) = 6.9490E+007
Mu2+ = 6.9490E+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- = 6.9490E+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

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808

fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00

v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 318579.655

Calculation of Shear Strength at edge 1, Vr1 = 318579.655
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 318579.655
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 6.2466256E-012
Vu = 6.3058752E-032
d = 0.8*h = 200.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 174534.321
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 500.00

Calculation of Shear Strength at edge 2, Vr2 = 318579.655
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 318579.655
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 6.2466256E-012
Vu = 6.3058752E-032
d = 0.8*h = 200.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 174534.321
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 500.00

End Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03851
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = -9.8607613E-031
EDGE -B-
Shear Force, Vb = 9.8607613E-031
BOTH EDGES
Axial Force, F = -4716.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 1017.876

Calculation of Shear Capacity ratio , Ve/Vr = 0.1905806
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 93977.957
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4097E+008
Mu1+ = 1.4097E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4097E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4097E+008
Mu2+ = 1.4097E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4097E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00

v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00

d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587

εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----

with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505

ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006

Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00

εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 493113.977

Calculation of Shear Strength at edge 1, Vr1 = 493113.977

Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 493113.977
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 3.0895806E-012
Vu = 9.8607613E-031
d = 0.8*h = 400.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 349068.643
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 493113.977
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 493113.977
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 3.0895806E-012
Vu = 9.8607613E-031
d = 0.8*h = 400.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 349068.643
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column C1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping

Stepwise Properties

Bending Moment, M = 1.1202468E-009
Shear Force, V2 = -4557.939
Shear Force, V3 = -4.1920510E-013
Axial Force, F = -4714.984
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL = 16.80

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00576926
θu = θy + θp = 0.00576926

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00576926 ((4.29),Biskinis Phd))
My = 6.0846E+007
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 5.2733E+012
factor = 0.30
Ag = 125000.00
fc' = 33.00
N = 4714.984
Ec*Ig = 1.7578E+013

Calculation of Yielding Moment My

Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 9.3590852E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 262.3043
d = 208.00
ξy = 0.32628121
A = 0.02590973
B = 0.01563972

with pt = 0.01093516
pc = 0.01093516
pv = 0.00386658
N = 4714.984
b = 500.00
δ" = 0.20192308
Φy_comp = 3.2535920E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.32509118
A = 0.02563386
B = 0.01546688
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.2321382
lb = 300.00
ld = 1292.334
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

- Calculation of θp -

From table 10-8: θp = 0.00
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.14541623
d = 208.00
s = 0.00
ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = 0.00
Av = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
bw = 500.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
NUD = 4714.984
Ag = 125000.00
f'cE = 33.00
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.02573689
b = 500.00
d = 208.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column C1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 3

column C1, Floor 1

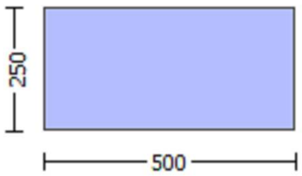
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

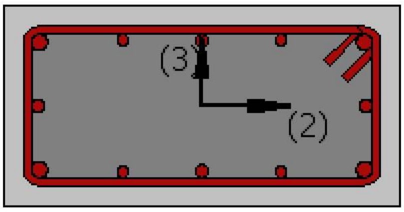
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)





Start Of Calculation of Shear Capacity for element: column C1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
###
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars

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

Stepwise Properties

EDGE -A-
Bending Moment, Ma = 1.1202468E-009
Shear Force, Va = -4.1920510E-013
EDGE -B-
Bending Moment, Mb = 1.3809565E-010
Shear Force, Vb = 4.1920510E-013
BOTH EDGES
Axial Force, F = -4714.984
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 282576.055
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 282576.055
VCol = 282576.055
knl = 1.00
displacement_ductility_demand = 0.00

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.1202468E-009
Vu = 4.1920510E-013
d = 0.8*h = 200.00
Nu = 4714.984
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 157079.633
Av = 157079.633
fy = 500.00
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 332151.915
bw = 500.00

----
displacement_ductility_demand is calculated as θ/θy

- Calculation of θ/θy for END A -
for rotation axis 2 and integ. section (a)

From analysis, chord rotation θ = 5.1523755E-020
θy = (My*Ls/3)/Eleff = 0.00576926 ((4.29),Biskinis Phd))
My = 6.0846E+007
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00

From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 5.2733E+012
factor = 0.30
Ag = 125000.00
fc' = 33.00
N = 4714.984
Ec*Ig = 1.7578E+013

Calculation of Yielding Moment My

Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 9.3590852E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 262.3043
d = 208.00
ξy = 0.32628121
A = 0.02590973
B = 0.01563972
with pt = 0.01093516
pc = 0.01093516
pv = 0.00386658
N = 4714.984
b = 500.00
δ'' = 0.20192308
Φy_comp = 3.2535920E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.32509118
A = 0.02563386
B = 0.01546688
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.2321382
lb = 300.00
ld = 1292.334
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

End Of Calculation of Shear Capacity for element: column C1 of floor 1
At local axis: 3
Integration Section: (a)

Calculation No. 4

column C1, Floor 1

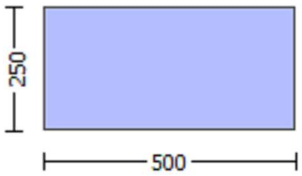
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

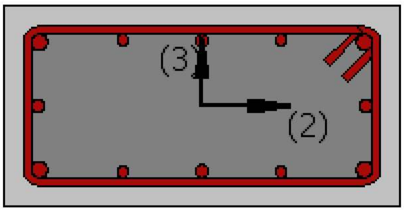
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (3)





Start Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03851
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -6.3058752E-032
EDGE -B-
Shear Force, Vb = 6.3058752E-032
BOTH EDGES
Axial Force, F = -4716.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.14541623
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 46326.653
with
Mpr1 = Max(Mu1+ , Mu1-) = 6.9490E+007
Mu1+ = 6.9490E+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- = 6.9490E+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-) = 6.9490E+007
Mu2+ = 6.9490E+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- = 6.9490E+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

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00

----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00

fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982

No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00

d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----

psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711

and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00

psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105

ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 318579.655

Calculation of Shear Strength at edge 1, Vr1 = 318579.655
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 318579.655
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 6.2466256E-012
Vu = 6.3058752E-032
d = 0.8*h = 200.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 174534.321
Av = 157079.633
fy = 555.56

s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 500.00

Calculation of Shear Strength at edge 2, Vr2 = 318579.655
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 318579.655
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 6.2466256E-012
Vu = 6.3058752E-032
d = 0.8*h = 200.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 174534.321
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 500.00

End Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03851
Element Length, L = 3000.00
Secondary Member
Smooth Bars

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

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = -9.8607613E-031
EDGE -B-
Shear Force, Vb = 9.8607613E-031
BOTH EDGES
Axial Force, F = -4716.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 1017.876

Calculation of Shear Capacity ratio , Ve/Vr = 0.1905806
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 93977.957
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4097E+008
Mu1+ = 1.4097E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4097E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4097E+008
Mu2+ = 1.4097E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4097E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00

psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733

ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00

ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587

with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261

ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 493113.977

Calculation of Shear Strength at edge 1, Vr1 = 493113.977
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 493113.977
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 3.0895806E-012
Vu = 9.8607613E-031

d = 0.8*h = 400.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 349068.643
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 493113.977
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 493113.977
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 3.0895806E-012
Vu = 9.8607613E-031
d = 0.8*h = 400.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 349068.643
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column C1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member

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

Stepwise Properties

Bending Moment, M = -1.3676E+007
Shear Force, V2 = -4557.939
Shear Force, V3 = -4.1920510E-013
Axial Force, F = -4714.984
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL = 18.66667

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00578405
θu = θy + θp = 0.00578405

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00578405 ((4.29),Biskinis Phd))
My = 1.2198E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3000.549
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.1093E+013
factor = 0.30
Ag = 125000.00
fc' = 33.00
N = 4714.984
Ec*Ig = 7.0311E+013

Calculation of Yielding Moment My

Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0836281E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 262.3043
d = 457.00
ξy = 0.29723032
A = 0.02358523
B = 0.01297347
with pt = 0.00725935
pc = 0.00725935
pv = 0.0089092
N = 4714.984
b = 250.00
δ'' = 0.0940919
Φy_comp = 1.6267960E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29592545
A = 0.0233341
B = 0.01281613

with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.2321382
lb = 300.00
ld = 1292.334
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

- Calculation of θp -

From table 10-8: θp = 0.00
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.1905806
d = 457.00
s = 0.00
ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = 0.00
Av = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
bw = 250.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
NUD = 4714.984
Ag = 125000.00
f'cE = 33.00
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.02342789
b = 250.00
d = 457.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column C1 of floor 1
At local axis: 3
Integration Section: (a)

Calculation No. 5

column C1, Floor 1

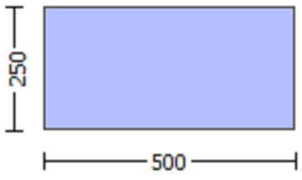
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

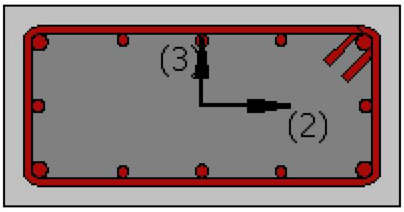
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)





Start Of Calculation of Shear Capacity for element: column C1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
###
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -1.3676E+007

Shear Force, Va = -4557.939
EDGE -B-
Bending Moment, Mb = 0.01695584
Shear Force, Vb = 4557.939
BOTH EDGES
Axial Force, F = -4714.984
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL,ten = 18.66667

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 439655.687
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 439655.687
VCol = 439655.687
knl = 1.00
displacement_ductility_demand = 0.16815869

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.01695584
Vu = 4557.939
d = 0.8*h = 400.00
Nu = 4714.984
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 314159.265
Av = 157079.633
fy = 500.00
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 332151.915
bw = 250.00

----
displacement_ductility_demand is calculated as θ/θy

- Calculation of θ/θy for END B -
for rotation axis 3 and integ. section (b)

From analysis, chord rotation θ = 9.7245966E-005
θy = (My*Ls/3)/Eleff = 0.0005783 ((4.29),Biskinis Phd))
My = 1.2198E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 2.1093E+013
factor = 0.30
Ag = 125000.00
fc' = 33.00
N = 4714.984
Ec*Ig = 7.0311E+013

Calculation of Yielding Moment My

Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0836281E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 262.3043
d = 457.00
ξy = 0.29723032
A = 0.02358523
B = 0.01297347
with pt = 0.00725935
pc = 0.00725935
pv = 0.0089092
N = 4714.984
b = 250.00
δ'' = 0.0940919
Φy_comp = 1.6267960E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29592545
A = 0.0233341
B = 0.01281613
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.2321382
lb = 300.00
ld = 1292.334
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

End Of Calculation of Shear Capacity for element: column C1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 6

column C1, Floor 1

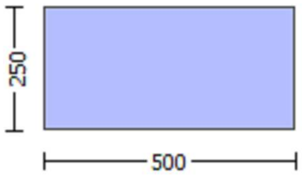
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

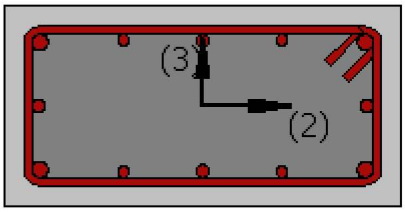
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (2)





Start Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03851
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -6.3058752E-032
EDGE -B-

Shear Force, Vb = 6.3058752E-032
BOTH EDGES
Axial Force, F = -4716.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.14541623
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 46326.653
with
Mpr1 = Max(Mu1+ , Mu1-) = 6.9490E+007
Mu1+ = 6.9490E+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- = 6.9490E+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-) = 6.9490E+007
Mu2+ = 6.9490E+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- = 6.9490E+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

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00

fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture

δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00

----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982

No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851

ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----

psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096

εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 318579.655

Calculation of Shear Strength at edge 1, Vr1 = 318579.655
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 318579.655
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 6.2466256E-012
Vu = 6.3058752E-032
d = 0.8*h = 200.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 174534.321
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 500.00

Calculation of Shear Strength at edge 2, Vr2 = 318579.655
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 318579.655
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 6.2466256E-012
Vu = 6.3058752E-032
d = 0.8*h = 200.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 174534.321
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 500.00

End Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03851
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = -9.8607613E-031
EDGE -B-
Shear Force, Vb = 9.8607613E-031
BOTH EDGES
Axial Force, F = -4716.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 1017.876

Calculation of Shear Capacity ratio , Ve/Vr = 0.1905806
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 93977.957
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4097E+008
Mu1+ = 1.4097E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4097E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4097E+008
Mu2+ = 1.4097E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4097E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----

psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096

εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00

bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00

d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159

Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:

b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159

----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 493113.977

Calculation of Shear Strength at edge 1, Vr1 = 493113.977
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 493113.977
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 3.0895806E-012
Vu = 9.8607613E-031
d = 0.8*h = 400.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 349068.643
Av = 157079.633
fy = 555.56
s = 100.00

Vs is multiplied by αCol = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 493113.977
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 493113.977
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 3.0895806E-012
Vu = 9.8607613E-031
d = 0.8*h = 400.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 349068.643
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column C1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping

Stepwise Properties

Bending Moment, M = 1.3809565E-010
Shear Force, V2 = 4557.939
Shear Force, V3 = 4.1920510E-013
Axial Force, F = -4714.984
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL = 16.80

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00576926
θu = θy + θp = 0.00576926

- Calculation of θy -

θy = (My*Ls/3)/Eleff = 0.00576926 ((4.29),Biskinis Phd))
My = 6.0846E+007
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 5.2733E+012
factor = 0.30
Ag = 125000.00
fc' = 33.00
N = 4714.984
Ec*Ig = 1.7578E+013

Calculation of Yielding Moment My

Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 9.3590852E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 262.3043
d = 208.00
ξy = 0.32628121
A = 0.02590973
B = 0.01563972
with pt = 0.01093516
pc = 0.01093516
pv = 0.00386658
N = 4714.984
b = 500.00
δ'' = 0.20192308
Φy_comp = 3.2535920E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.32509118
A = 0.02563386
B = 0.01546688
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.2321382

lb = 300.00
ld = 1292.334
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

- Calculation of θp -

From table 10-8: θp = 0.00
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.14541623
d = 208.00
s = 0.00
ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = 0.00
Av = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
bw = 500.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
NUD = 4714.984
Ag = 125000.00
f'cE = 33.00
fytE = fylE = 0.00
ρl = Area_Tot_Long_Rein/(b*d) = 0.02573689
b = 500.00
d = 208.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column C1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 7

column C1, Floor 1

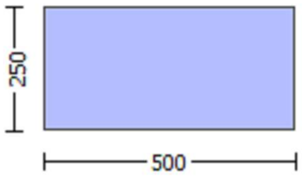
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

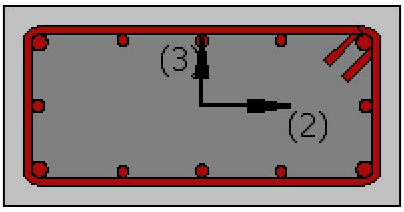
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)





Start Of Calculation of Shear Capacity for element: column C1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
##
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = 1.1202468E-009

Shear Force, Va = -4.1920510E-013
EDGE -B-
Bending Moment, Mb = 1.3809565E-010
Shear Force, Vb = 4.1920510E-013
BOTH EDGES
Axial Force, F = -4714.984
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 282576.055
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 282576.055
VCol = 282576.055
knl = 1.00
displacement_ductility_demand = 0.00

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.3809565E-010
Vu = 4.1920510E-013
d = 0.8*h = 200.00
Nu = 4714.984
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 157079.633
Av = 157079.633
fy = 500.00
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 332151.915
bw = 500.00

----
displacement_ductility_demand is calculated as θ/θy

- Calculation of θ/θy for END B -
for rotation axis 2 and integ. section (b)

From analysis, chord rotation θ = 2.3884870E-020
θy = (My*Ls/3)/Eleff = 0.00576926 ((4.29),Biskinis Phd))
My = 6.0846E+007
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 5.2733E+012
factor = 0.30
Ag = 125000.00
fc' = 33.00
N = 4714.984
Ec*Ig = 1.7578E+013

Calculation of Yielding Moment My

Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 9.3590852E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 262.3043
d = 208.00
ξy = 0.32628121
A = 0.02590973
B = 0.01563972
with pt = 0.01093516
pc = 0.01093516
pv = 0.00386658
N = 4714.984
b = 500.00
δ" = 0.20192308
Φy_comp = 3.2535920E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.32509118
A = 0.02563386
B = 0.01546688
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.2321382
lb = 300.00
ld = 1292.334
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

End Of Calculation of Shear Capacity for element: column C1 of floor 1
At local axis: 3
Integration Section: (b)

Calculation No. 8

column C1, Floor 1

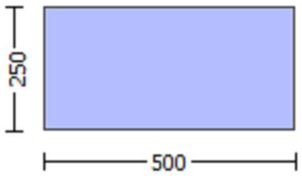
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

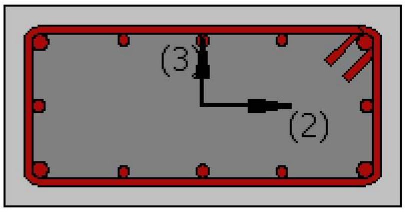
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (3)





Start Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03851
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -6.3058752E-032
EDGE -B-

Shear Force, Vb = 6.3058752E-032
BOTH EDGES
Axial Force, F = -4716.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.14541623
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 46326.653
with
Mpr1 = Max(Mu1+ , Mu1-) = 6.9490E+007
Mu1+ = 6.9490E+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- = 6.9490E+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-) = 6.9490E+007
Mu2+ = 6.9490E+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- = 6.9490E+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

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00

fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture

δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00

----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982

No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851

ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----

psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096

εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 318579.655

Calculation of Shear Strength at edge 1, Vr1 = 318579.655
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 318579.655
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 6.2466256E-012
Vu = 6.3058752E-032
d = 0.8*h = 200.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 174534.321
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 500.00

Calculation of Shear Strength at edge 2, Vr2 = 318579.655
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 318579.655
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 6.2466256E-012
Vu = 6.3058752E-032
d = 0.8*h = 200.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 174534.321
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 500.00

End Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03851
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = -9.8607613E-031
EDGE -B-
Shear Force, Vb = 9.8607613E-031
BOTH EDGES
Axial Force, F = -4716.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 1017.876

Calculation of Shear Capacity ratio , Ve/Vr = 0.1905806
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 93977.957
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4097E+008
Mu1+ = 1.4097E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4097E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4097E+008
Mu2+ = 1.4097E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4097E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----

psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096

εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00

bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00

d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159

Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:

b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159

----

psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00

----

psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00

----

s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 493113.977

Calculation of Shear Strength at edge 1, Vr1 = 493113.977
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 493113.977
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 3.0895806E-012
Vu = 9.8607613E-031
d = 0.8*h = 400.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 349068.643
Av = 157079.633
fy = 555.56
s = 100.00

Vs is multiplied by αCol = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 493113.977
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 493113.977
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 3.0895806E-012
Vu = 9.8607613E-031
d = 0.8*h = 400.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 349068.643
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column C1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping

Stepwise Properties

Bending Moment, M = 0.01695584
Shear Force, V2 = 4557.939
Shear Force, V3 = 4.1920510E-013
Axial Force, F = -4714.984
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL = 18.66667

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.0005783
θu = θy + θp = 0.0005783

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.0005783 ((4.29),Biskinis Phd))
My = 1.2198E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.1093E+013
factor = 0.30
Ag = 125000.00
fc' = 33.00
N = 4714.984
Ec*Ig = 7.0311E+013

Calculation of Yielding Moment My

Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0836281E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 262.3043
d = 457.00
ξy = 0.29723032
A = 0.02358523
B = 0.01297347
with pt = 0.00725935
pc = 0.00725935
pv = 0.0089092
N = 4714.984
b = 250.00
δ'' = 0.0940919
Φy_comp = 1.6267960E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29592545
A = 0.0233341
B = 0.01281613
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.2321382

lb = 300.00
ld = 1292.334
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

- Calculation of θp -

From table 10-8: θp = 0.00
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.1905806
d = 457.00
s = 0.00
ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = 0.00
Av = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
bw = 250.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
NUD = 4714.984
Ag = 125000.00
f'cE = 33.00
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.02342789
b = 250.00
d = 457.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column C1 of floor 1
At local axis: 3
Integration Section: (b)

Calculation No. 9

column C1, Floor 1

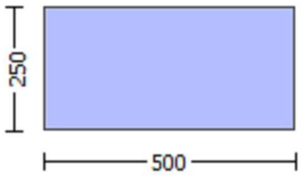
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

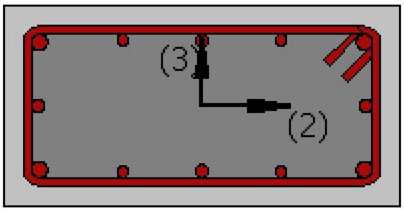
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)





Start Of Calculation of Shear Capacity for element: column C1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
###
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -1.6521E+007

Shear Force, Va = -5505.965
EDGE -B-
Bending Moment, Mb = 0.02048256
Shear Force, Vb = 5505.965
BOTH EDGES
Axial Force, F = -4714.605
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1137.257
-Compression: Aslc = 1539.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL,ten = 18.66667

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 376907.439
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 376907.439
VCol = 376907.439
knl = 1.00
displacement_ductility_demand = 0.03718818

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
Mu = 1.6521E+007
Vu = 5505.965
d = 0.8*h = 400.00
Nu = 4714.605
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 314159.265
Av = 157079.633
fy = 500.00
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 332151.915
bw = 250.00

----
displacement_ductility_demand is calculated as θ/θy

- Calculation of θ/θy for END A -
for rotation axis 3 and integ. section (a)

From analysis, chord rotation θ = 0.0002151
θy = (My*Ls/3)/EIeff = 0.00578404 ((4.29),Biskinis Phd))
My = 1.2198E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3000.549
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.1093E+013
factor = 0.30
Ag = 125000.00
fc' = 33.00
N = 4714.605
Ec*Ig = 7.0311E+013

Calculation of Yielding Moment My

Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0836273E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 262.3043
d = 457.00
ξy = 0.29723018
A = 0.02358521
B = 0.01297345
with pt = 0.00725935
pc = 0.00725935
pv = 0.0089092
N = 4714.605
b = 250.00
δ'' = 0.0940919
Φy_comp = 1.6267962E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29592542
A = 0.02333411
B = 0.01281613
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.2321382
lb = 300.00
ld = 1292.334
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

End Of Calculation of Shear Capacity for element: column C1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 10

column C1, Floor 1

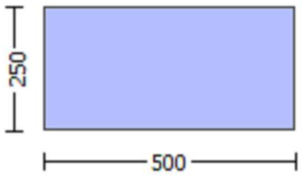
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

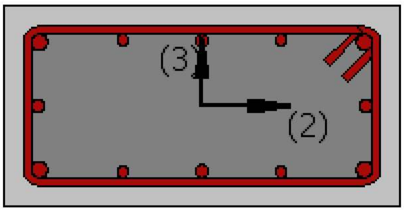
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (2)





Start Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03851
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -6.3058752E-032
EDGE -B-

Shear Force, Vb = 6.3058752E-032
BOTH EDGES
Axial Force, F = -4716.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.14541623
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 46326.653
with
Mpr1 = Max(Mu1+ , Mu1-) = 6.9490E+007
Mu1+ = 6.9490E+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- = 6.9490E+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-) = 6.9490E+007
Mu2+ = 6.9490E+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- = 6.9490E+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

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00

fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture

δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00

----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982

No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851

ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----

psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096

εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 318579.655

Calculation of Shear Strength at edge 1, Vr1 = 318579.655
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 318579.655
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 6.2466256E-012
Vu = 6.3058752E-032
d = 0.8*h = 200.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 174534.321
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 500.00

Calculation of Shear Strength at edge 2, Vr2 = 318579.655
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 318579.655
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 6.2466256E-012
Vu = 6.3058752E-032
d = 0.8*h = 200.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 174534.321
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 500.00

End Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03851
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = -9.8607613E-031
EDGE -B-
Shear Force, Vb = 9.8607613E-031
BOTH EDGES
Axial Force, F = -4716.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 1017.876

Calculation of Shear Capacity ratio , Ve/Vr = 0.1905806
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 93977.957
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4097E+008
Mu1+ = 1.4097E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4097E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4097E+008
Mu2+ = 1.4097E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4097E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----

psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096

εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00

bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00

d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159

Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:

b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159

----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 493113.977

Calculation of Shear Strength at edge 1, Vr1 = 493113.977
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 493113.977
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 3.0895806E-012
Vu = 9.8607613E-031
d = 0.8*h = 400.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 349068.643
Av = 157079.633
fy = 555.56
s = 100.00

Vs is multiplied by αCol = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 493113.977
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 493113.977
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 3.0895806E-012
Vu = 9.8607613E-031
d = 0.8*h = 400.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 349068.643
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column C1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping

Stepwise Properties

Bending Moment, M = 1.3519525E-009
Shear Force, V2 = -5505.965
Shear Force, V3 = -5.0639738E-013
Axial Force, F = -4714.605
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1137.257
-Compression: Aslc = 1539.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL = 16.80

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.02636881
θu = θy + θp = 0.02636881

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00576926 ((4.29),Biskinis Phd))
My = 6.0846E+007
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 5.2733E+012
factor = 0.30
Ag = 125000.00
fc' = 33.00
N = 4714.605
Ec*Ig = 1.7578E+013

Calculation of Yielding Moment My

Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 9.3590834E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 262.3043
d = 208.00
ξy = 0.32628107
A = 0.02590972
B = 0.01563971
with pt = 0.01093516
pc = 0.01093516
pv = 0.00386658
N = 4714.605
b = 500.00
δ'' = 0.20192308
Φy_comp = 3.2535924E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.32509114
A = 0.02563387
B = 0.01546688
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.2321382

lb = 300.00
ld = 1292.334
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

- Calculation of θp -

From table 10-8: θp = 0.02059956
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.14541623
d = 208.00
s = 0.00
ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = 0.00
Av = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
bw = 500.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
NUD = 4714.605
Ag = 125000.00
f'cE = 33.00
fytE = fylE = 0.00
ρl = Area_Tot_Long_Rein/(b*d) = 0.02573689
b = 500.00
d = 208.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column C1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 11

column C1, Floor 1

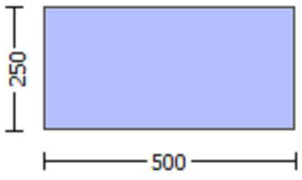
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

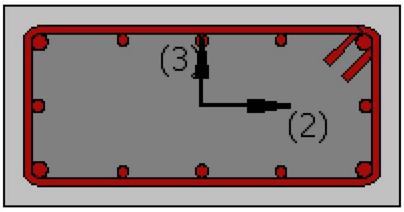
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)





Start Of Calculation of Shear Capacity for element: column C1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
###
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = 1.3519525E-009

Shear Force, Va = -5.0639738E-013
EDGE -B-
Bending Moment, Mb = 1.6811803E-010
Shear Force, Vb = 5.0639738E-013
BOTH EDGES
Axial Force, F = -4714.605
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1137.257
-Compression: Aslc = 1539.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 282575.979
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 282575.979
VCol = 282575.979
knl = 1.00
displacement_ductility_demand = 0.00

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.3519525E-009
Vu = 5.0639738E-013
d = 0.8*h = 200.00
Nu = 4714.605
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 157079.633
Av = 157079.633
fy = 500.00
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 332151.915
bw = 500.00

----
displacement_ductility_demand is calculated as θ/θy

- Calculation of θ/θy for END A -
for rotation axis 2 and integ. section (a)

From analysis, chord rotation θ = 6.2240403E-020
θy = (My*Ls/3)/EIeff = 0.00576926 ((4.29),Biskinis Phd))
My = 6.0846E+007
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 5.2733E+012
factor = 0.30
Ag = 125000.00
fc' = 33.00
N = 4714.605
Ec*Ig = 1.7578E+013

Calculation of Yielding Moment My

Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 9.3590834E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 262.3043
d = 208.00
ξy = 0.32628107
A = 0.02590972
B = 0.01563971
with pt = 0.01093516
pc = 0.01093516
pv = 0.00386658
N = 4714.605
b = 500.00
δ'' = 0.20192308
Φy_comp = 3.2535924E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.32509114
A = 0.02563387
B = 0.01546688
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.2321382
lb = 300.00
ld = 1292.334
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

End Of Calculation of Shear Capacity for element: column C1 of floor 1
At local axis: 3
Integration Section: (a)

Calculation No. 12

column C1, Floor 1

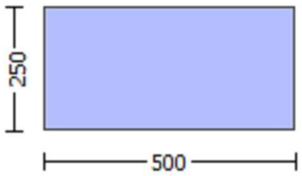
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

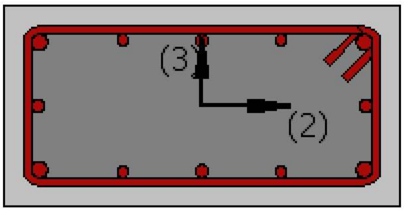
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (3)





Start Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03851
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -6.3058752E-032
EDGE -B-

Shear Force, Vb = 6.3058752E-032
BOTH EDGES
Axial Force, F = -4716.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.14541623
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 46326.653
with
Mpr1 = Max(Mu1+ , Mu1-) = 6.9490E+007
Mu1+ = 6.9490E+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- = 6.9490E+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-) = 6.9490E+007
Mu2+ = 6.9490E+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- = 6.9490E+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

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00

fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture

δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
  λ = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 694.45
  fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  ψt = 1.00
  ψs = 0.80
  ψe = 1.00
  cb = 25.00
  Ktr = 5.23599
    Atr = Min(Atr_x,Atr_y) = 157.0796
    where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
    s = 100.00
    n = 12.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
  b = 500.00
  d = 208.00
  d' = 42.00
  v = 0.00137436
    N = 4716.808
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.00591084
    ωwe (5.4c) = 0.00363261
      ase ((5.4d), TBDY) = 0.05494666
        bo = 440.00
        ho = 190.00
        Σbi2 = 459400.00
      psh,min = Min(psh,x , psh,y) = 0.00314159
    ----
      psh,x (5.4d) = 0.00314159
        Ash = Astir*ns = 78.53982
          No stirups, ns = 2.00
        bk = 500.00
    ----
      psh,y (5.4d) = 0.00628319
        Ash = Astir*ns = 78.53982
          No stirups, ns = 2.00
        bk = 250.00

----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982

No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851

ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----

psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096

εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 318579.655

Calculation of Shear Strength at edge 1, Vr1 = 318579.655
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 318579.655
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 6.2466256E-012
Vu = 6.3058752E-032
d = 0.8*h = 200.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 174534.321
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 500.00

Calculation of Shear Strength at edge 2, Vr2 = 318579.655
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 318579.655
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 6.2466256E-012
Vu = 6.3058752E-032
d = 0.8*h = 200.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 174534.321
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 500.00

End Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03851
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = -9.8607613E-031
EDGE -B-
Shear Force, Vb = 9.8607613E-031
BOTH EDGES
Axial Force, F = -4716.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 1017.876

Calculation of Shear Capacity ratio , Ve/Vr = 0.1905806
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 93977.957
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4097E+008
Mu1+ = 1.4097E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4097E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4097E+008
Mu2+ = 1.4097E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4097E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----

psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096

εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00

bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00

d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159

Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:

b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159

----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 493113.977

Calculation of Shear Strength at edge 1, Vr1 = 493113.977
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 493113.977
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 3.0895806E-012
Vu = 9.8607613E-031
d = 0.8*h = 400.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 349068.643
Av = 157079.633
fy = 555.56
s = 100.00

Vs is multiplied by αCol = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 493113.977
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 493113.977
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 3.0895806E-012
Vu = 9.8607613E-031
d = 0.8*h = 400.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 349068.643
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column C1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping

Stepwise Properties

Bending Moment, M = -1.6521E+007
Shear Force, V2 = -5505.965
Shear Force, V3 = -5.0639738E-013
Axial Force, F = -4714.605
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1137.257
-Compression: Aslc = 1539.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL = 18.66667

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.03578404
θu = θy + θp = 0.03578404

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00578404 ((4.29),Biskinis Phd))
My = 1.2198E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3000.549
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.1093E+013
factor = 0.30
Ag = 125000.00
fc' = 33.00
N = 4714.605
Ec*Ig = 7.0311E+013

Calculation of Yielding Moment My

Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0836273E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 262.3043
d = 457.00
ξy = 0.29723018
A = 0.02358521
B = 0.01297345
with pt = 0.00725935
pc = 0.00725935
pv = 0.0089092
N = 4714.605
b = 250.00
δ'' = 0.0940919
Φy_comp = 1.6267962E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29592542
A = 0.02333411
B = 0.01281613
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.2321382

lb = 300.00
ld = 1292.334
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

- Calculation of θp -

From table 10-8: θp = 0.03
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.1905806
d = 457.00
s = 0.00
ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = 0.00
Av = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
bw = 250.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
NUD = 4714.605
Ag = 125000.00
f'cE = 33.00
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.02342789
b = 250.00
d = 457.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column C1 of floor 1
At local axis: 3
Integration Section: (a)

Calculation No. 13

column C1, Floor 1

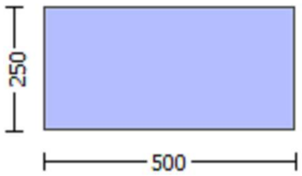
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

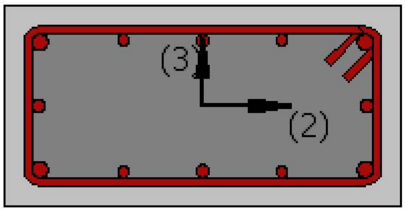
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)





Start Of Calculation of Shear Capacity for element: column C1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
###
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -1.6521E+007

Shear Force, Va = -5505.965
EDGE -B-
Bending Moment, Mb = 0.02048256
Shear Force, Vb = 5505.965
BOTH EDGES
Axial Force, F = -4714.605
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL,ten = 18.66667

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 439655.612
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 439655.612
VCol = 439655.612
knl = 1.00
displacement_ductility_demand = 0.20313486

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.02048256
Vu = 5505.965
d = 0.8*h = 400.00
Nu = 4714.605
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 314159.265
Av = 157079.633
fy = 500.00
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 332151.915
bw = 250.00

----
displacement_ductility_demand is calculated as θ/θy

- Calculation of θ/θy for END B -
for rotation axis 3 and integ. section (b)

From analysis, chord rotation θ = 0.00011747
θy = (My*Ls/3)/EIeff = 0.0005783 ((4.29),Biskinis Phd))
My = 1.2198E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.1093E+013
factor = 0.30
Ag = 125000.00
fc' = 33.00
N = 4714.605
Ec*Ig = 7.0311E+013

Calculation of Yielding Moment My

Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0836273E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 262.3043
d = 457.00
ξy = 0.29723018
A = 0.02358521
B = 0.01297345
with pt = 0.00725935
pc = 0.00725935
pv = 0.0089092
N = 4714.605
b = 250.00
δ'' = 0.0940919
Φy_comp = 1.6267962E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29592542
A = 0.02333411
B = 0.01281613
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.2321382
lb = 300.00
ld = 1292.334
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

End Of Calculation of Shear Capacity for element: column C1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 14

column C1, Floor 1

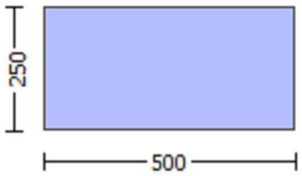
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

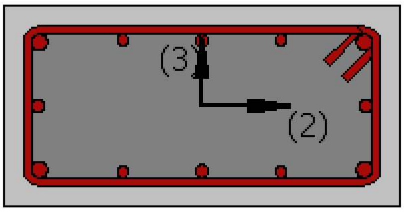
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (2)





Start Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03851
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -6.3058752E-032
EDGE -B-

Shear Force, Vb = 6.3058752E-032
BOTH EDGES
Axial Force, F = -4716.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.14541623
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 46326.653
with
Mpr1 = Max(Mu1+ , Mu1-) = 6.9490E+007
Mu1+ = 6.9490E+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- = 6.9490E+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-) = 6.9490E+007
Mu2+ = 6.9490E+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- = 6.9490E+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

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00

fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture

δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00

----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982

No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851

ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----

psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096

εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 318579.655

Calculation of Shear Strength at edge 1, Vr1 = 318579.655
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 318579.655
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 6.2466256E-012
Vu = 6.3058752E-032
d = 0.8*h = 200.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 174534.321
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 500.00

Calculation of Shear Strength at edge 2, Vr2 = 318579.655
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 318579.655
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 6.2466256E-012
Vu = 6.3058752E-032
d = 0.8*h = 200.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 174534.321
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 500.00

End Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03851
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = -9.8607613E-031
EDGE -B-
Shear Force, Vb = 9.8607613E-031
BOTH EDGES
Axial Force, F = -4716.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 1017.876

Calculation of Shear Capacity ratio , Ve/Vr = 0.1905806
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 93977.957
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4097E+008
Mu1+ = 1.4097E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4097E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4097E+008
Mu2+ = 1.4097E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4097E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----

psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096

εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00

bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00

d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159

Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:

b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159

----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 493113.977

Calculation of Shear Strength at edge 1, Vr1 = 493113.977
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 493113.977
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 3.0895806E-012
Vu = 9.8607613E-031
d = 0.8*h = 400.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 349068.643
Av = 157079.633
fy = 555.56
s = 100.00

Vs is multiplied by αCol = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 493113.977
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 493113.977
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 3.0895806E-012
Vu = 9.8607613E-031
d = 0.8*h = 400.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 349068.643
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column C1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping

Stepwise Properties

Bending Moment, M = 1.6811803E-010
Shear Force, V2 = 5505.965
Shear Force, V3 = 5.0639738E-013
Axial Force, F = -4714.605
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL = 16.80

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.02636881
θu = θy + θp = 0.02636881

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00576926 ((4.29),Biskinis Phd))
My = 6.0846E+007
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 5.2733E+012
factor = 0.30
Ag = 125000.00
fc' = 33.00
N = 4714.605
Ec*Ig = 1.7578E+013

Calculation of Yielding Moment My

Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 9.3590834E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 262.3043
d = 208.00
ξy = 0.32628107
A = 0.02590972
B = 0.01563971
with pt = 0.01093516
pc = 0.01093516
pv = 0.00386658
N = 4714.605
b = 500.00
δ'' = 0.20192308
Φy_comp = 3.2535924E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.32509114
A = 0.02563387
B = 0.01546688
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.2321382

lb = 300.00
ld = 1292.334
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

- Calculation of θp -

From table 10-8: θp = 0.02059956
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.14541623
d = 208.00
s = 0.00
ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = 0.00
Av = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
bw = 500.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
NUD = 4714.605
Ag = 125000.00
f'cE = 33.00
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.02573689
b = 500.00
d = 208.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column C1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 15

column C1, Floor 1

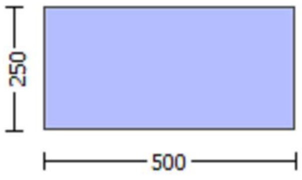
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

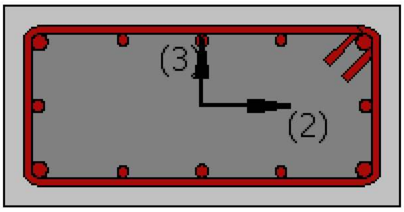
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)





Start Of Calculation of Shear Capacity for element: column C1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
##
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = 1.3519525E-009

Shear Force, Va = -5.0639738E-013
EDGE -B-
Bending Moment, Mb = 1.6811803E-010
Shear Force, Vb = 5.0639738E-013
BOTH EDGES
Axial Force, F = -4714.605
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 282575.979
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 282575.979
VCol = 282575.979
knl = 1.00
displacement_ductility_demand = 0.00

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.6811803E-010
Vu = 5.0639738E-013
d = 0.8*h = 200.00
Nu = 4714.605
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 157079.633
Av = 157079.633
fy = 500.00
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 332151.915
bw = 500.00

----
displacement_ductility_demand is calculated as θ/θy

- Calculation of θ/θy for END B -
for rotation axis 2 and integ. section (b)

From analysis, chord rotation θ = 2.8852788E-020
θy = (My*Ls/3)/Eleff = 0.00576926 ((4.29),Biskinis Phd))
My = 6.0846E+007
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 5.2733E+012
factor = 0.30
Ag = 125000.00
fc' = 33.00
N = 4714.605
Ec*Ig = 1.7578E+013

Calculation of Yielding Moment My

Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 9.3590834E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 262.3043
d = 208.00
ξy = 0.32628107
A = 0.02590972
B = 0.01563971
with pt = 0.01093516
pc = 0.01093516
pv = 0.00386658
N = 4714.605
b = 500.00
δ" = 0.20192308
Φy_comp = 3.2535924E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.32509114
A = 0.02563387
B = 0.01546688
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.2321382
lb = 300.00
ld = 1292.334
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

End Of Calculation of Shear Capacity for element: column C1 of floor 1
At local axis: 3
Integration Section: (b)

Calculation No. 16

column C1, Floor 1

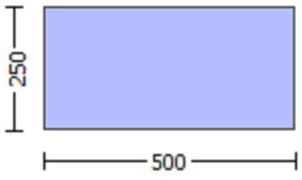
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

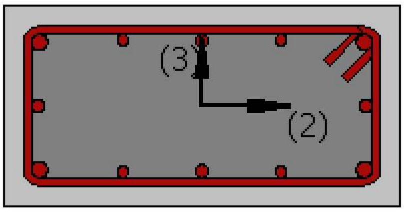
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (3)





Start Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03851
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -6.3058752E-032
EDGE -B-

Shear Force, Vb = 6.3058752E-032
BOTH EDGES
Axial Force, F = -4716.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.14541623
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 46326.653
with
Mpr1 = Max(Mu1+ , Mu1-) = 6.9490E+007
Mu1+ = 6.9490E+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- = 6.9490E+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-) = 6.9490E+007
Mu2+ = 6.9490E+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- = 6.9490E+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

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00

fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture

δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00

----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982

No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851

ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 2.1109865E-005
Mu = 6.9490E+007
----
with full section properties:
b = 500.00
d = 208.00
d' = 42.00
v = 0.00137436
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----

psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09363105
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09363105
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03310711
and confined core properties:
b = 440.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 34.27096

εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12433132
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12433132
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04396246
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.25867449
Mu = MRc (4.14) = 6.9490E+007
φu = φsu (4.1) = 2.1109865E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 318579.655

Calculation of Shear Strength at edge 1, Vr1 = 318579.655
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 318579.655
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 6.2466256E-012
Vu = 6.3058752E-032
d = 0.8*h = 200.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 174534.321
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 500.00

Calculation of Shear Strength at edge 2, Vr2 = 318579.655
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 318579.655
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 6.2466256E-012
Vu = 6.3058752E-032
d = 0.8*h = 200.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 174534.321
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 500.00

End Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Mean strength values are used for both shear and moment calculations.
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03851
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = -9.8607613E-031
EDGE -B-
Shear Force, Vb = 9.8607613E-031
BOTH EDGES
Axial Force, F = -4716.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 1017.876

Calculation of Shear Capacity ratio , Ve/Vr = 0.1905806
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 93977.957
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4097E+008
Mu1+ = 1.4097E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4097E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4097E+008
Mu2+ = 1.4097E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4097E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----

psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096

εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00

bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00

d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159
----
psh,x (5.4d) = 0.00314159

Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:

b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 9.2475766E-006
Mu = 1.4097E+008
----
with full section properties:
b = 250.00
d = 457.00
d' = 43.00
v = 0.00125106
N = 4716.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00591084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00591084
ωwe (5.4c) = 0.00363261
ase ((5.4d), TBDY) = 0.05494666
bo = 440.00
ho = 190.00
Σbi2 = 459400.00
psh,min = Min(psh,x , psh,y) = 0.00314159

----
psh,x (5.4d) = 0.00314159
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 500.00
----
psh,y (5.4d) = 0.00628319
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 250.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238514
λc = confinement factor = 1.03851
εy1 = 0.0010172
εsh1 = 0.00325505
ft1 = 339.0705
fy1 = 282.5587
εsu1 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 282.5587
with Es1 = Es = 200000.00
εy2 = 0.0010172
εsh2 = 0.00325505
ft2 = 339.0705
fy2 = 282.5587
εsu2 = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18571056
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 282.5587
with Es2 = Es = 200000.00
εyv = 0.0010172
εshv = 0.00325505
ftv = 339.0705
fyv = 282.5587
εsuv = 0.00325505
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.18571056
εsuv = 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 εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 282.5587
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06215733
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06215733

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.076284
and confined core properties:
b = 190.00
d = 427.00
d' = 13.00
fcc (5A.2, TBDY) = 34.27096
εcc (5A.5, TBDY) = 0.00238514
λc = confinement factor = 1.03851
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.08753205
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.08753205
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1074257
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.22978211
Mu = MRc (4.14) = 1.4097E+008
φu = φsu (4.1) = 9.2475766E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18571056
lb = 300.00
ld = 1615.417
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 493113.977

Calculation of Shear Strength at edge 1, Vr1 = 493113.977
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 493113.977
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 3.0895806E-012
Vu = 9.8607613E-031
d = 0.8*h = 400.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 349068.643
Av = 157079.633
fy = 555.56
s = 100.00

Vs is multiplied by αCol = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 493113.977
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 493113.977
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

λ = 1 (normal-weight concrete)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 3.0895806E-012
Vu = 9.8607613E-031
d = 0.8*h = 400.00
Nu = 4716.808
Ag = 125000.00
From (11.5.4.8), ACI 318-14: Vs = 349068.643
Av = 157079.633
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 381613.496
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column C1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column C1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcrs

Constant Properties

Knowledge Factor, κ = 0.95
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Section Height, H = 250.00
Section Width, W = 500.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping

Stepwise Properties

Bending Moment, M = 0.02048256
Shear Force, V2 = 5505.965
Shear Force, V3 = 5.0639738E-013
Axial Force, F = -4714.605
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL = 18.66667

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.0305783
θu = θy + θp = 0.0305783

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.0005783 ((4.29),Biskinis Phd))
My = 1.2198E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.1093E+013
factor = 0.30
Ag = 125000.00
fc' = 33.00
N = 4714.605
Ec*Ig = 7.0311E+013

Calculation of Yielding Moment My

Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0836273E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 262.3043
d = 457.00
ξy = 0.29723018
A = 0.02358521
B = 0.01297345
with pt = 0.00725935
pc = 0.00725935
pv = 0.0089092
N = 4714.605
b = 250.00
δ'' = 0.0940919
Φy_comp = 1.6267962E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29592542
A = 0.02333411
B = 0.01281613
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.2321382

lb = 300.00
ld = 1292.334
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.66667
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 5.23599
Atr = Min(Atr_x,Atr_y) = 157.0796
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = 100.00
n = 12.00

- Calculation of θp -

From table 10-8: θp = 0.03
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.1905806
d = 457.00
s = 0.00
ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = 0.00
Av = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
bw = 250.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
NUD = 4714.605
Ag = 125000.00
f'cE = 33.00
fytE = fylE = 0.00
ρl = Area_Tot_Long_Rein/(b*d) = 0.02342789
b = 250.00
d = 457.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column C1 of floor 1
At local axis: 3
Integration Section: (b)
