Detailed Member Calculations

Units: N&mm

Regulation: ASCE 41-17

Calculation No. 1

column C1, Floor 1

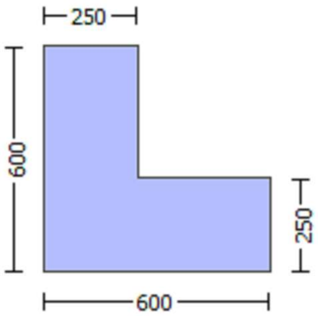
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

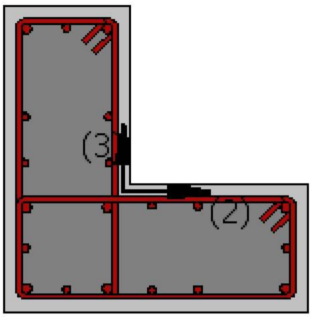
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)





Start Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
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 = -1.6421E+007
Shear Force, Va = -5376.74
EDGE -B-
Bending Moment, Mb = 286361.129
Shear Force, Vb = 5376.74
BOTH EDGES
Axial Force, F = -9834.091
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL,ten = 17.25

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 474293.501
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 474293.501
VCol = 474293.501
knl = 1.00
displacement_ductility_demand = 0.01958511

NOTE: In expression (10-3) 'Vs' 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 = 1.6421E+007
Vu = 5376.74
d = 0.8*h = 480.00
Nu = 9834.091
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 534070.751
where:
Vs1 = 157079.633 is calculated for section web, with:
d = 200.00
Av = 157079.633

fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.50
Vs2 = 376991.118 is calculated for section flange, with:
d = 480.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 398582.298
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 = 0.00010636
θy = (My*Ls/3)/EIeff = 0.00543078 ((4.29),Biskinis Phd))
My = 2.8727E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3053.989
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 5.3849E+013
factor = 0.30
Ag = 237500.00
fc' = 33.00
N = 9834.091
Ec*Ig = 1.7950E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.4238311E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 239.763
d = 558.00
ξy = 0.37251172
A = 0.03425475
B = 0.02212674
with pt = 0.01362483
pc = 0.00594538
pv = 0.01439052
N = 9834.091
b = 250.00
δ'' = 0.07706093
Φy_comp = 1.0626579E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.37102564
A = 0.03380052
B = 0.02183272
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.20286715
lb = 300.00
ld = 1478.80

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 = 17.20
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 = 3.14159
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 = 20.00

End Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 2

column C1, Floor 1

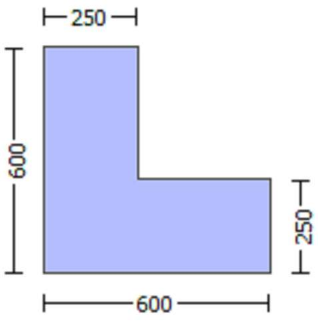
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

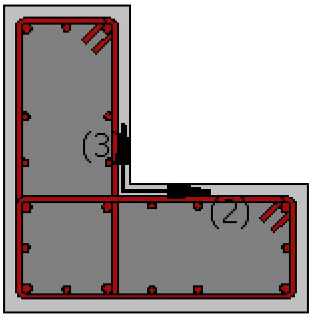
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (2)





Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00

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
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.20966
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 = -0.14001342
EDGE -B-
Shear Force, Vb = 0.14001342
BOTH EDGES
Axial Force, F = -8933.736
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 0.47866965
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 260725.615
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9109E+008
Mu1+ = 3.9109E+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- = 1.6345E+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-) = 3.9109E+008
Mu2+ = 3.9109E+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- = 1.6345E+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 = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50

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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966

εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->

v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982

Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00

d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 544688.006

Calculation of Shear Strength at edge 1, Vr1 = 544688.006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 544688.006
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 4.00
Mu = 330.6145
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 418882.372 is calculated for section web, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00

s/d = 0.20833333
Vs2 = 174534.321 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 631439.816
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 631439.816
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 90.27247
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 418882.372 is calculated for section web, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.20833333
Vs2 = 174534.321 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.20966
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 = -0.14001342
EDGE -B-
Shear Force, Vb = 0.14001342
BOTH EDGES
Axial Force, F = -8933.736
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 0.47866965
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 260725.615
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9109E+008
Mu1+ = 3.9109E+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- = 1.6345E+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-) = 3.9109E+008
Mu2+ = 3.9109E+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- = 1.6345E+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 = 7.6057310E-006
Mu = 3.9109E+008

----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372

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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.6057310E-006
Mu = 3.9109E+008

----

with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813

----

psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----

psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----

s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322

fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333

Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813

Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658

λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 544688.006

Calculation of Shear Strength at edge 1, Vr1 = 544688.006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 544688.006
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 4.00
Mu = 330.6037
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 174534.321 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.50
Vs2 = 418882.372 is calculated for section flange, with:
d = 480.00

Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 631439.816
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 631439.816
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 90.28316
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 174534.321 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.50
Vs2 = 418882.372 is calculated for section flange, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
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 = -639020.835
Shear Force, V2 = -5376.74
Shear Force, V3 = 294.5033
Axial Force, F = -9834.091
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL = 17.25

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00385851
θu = θy + θp = 0.00385851

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00385851 ((4.29),Biskinis Phd))
My = 2.8727E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 2169.826
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 5.3849E+013
factor = 0.30
Ag = 237500.00
fc' = 33.00
N = 9834.091
Ec*Ig = 1.7950E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.4238311E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 239.763
d = 558.00
ξy = 0.37251172
A = 0.03425475
B = 0.02212674
with pt = 0.01362483
pc = 0.00594538
pv = 0.01439052
N = 9834.091

b = 250.00
δ" = 0.07706093
Φy_comp = 1.0626579E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.37102564
A = 0.03380052
B = 0.02183272
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.20286715
lb = 300.00
ld = 1478.80
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 = 17.20
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 = 3.14159
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 = 20.00

- 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 = 0.47866965
d = 558.00
s = 0.00
ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = Av*Lstir/(Ag*s) + 2*tf/bw*(ffe/fs) = 0.00
Av = 78.53982, is the area of every stirrup
Lstir = 1460.00, is the total Length of all stirrups parallel to loading (shear) direction
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 = 9834.091
Ag = 237500.00
f'cE = 33.00
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.03396073
b = 250.00
d = 558.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 3

column C1, Floor 1

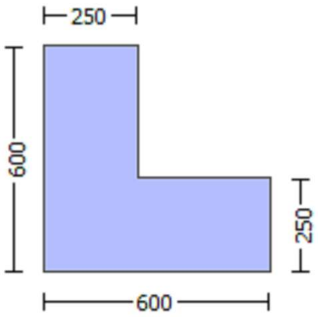
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

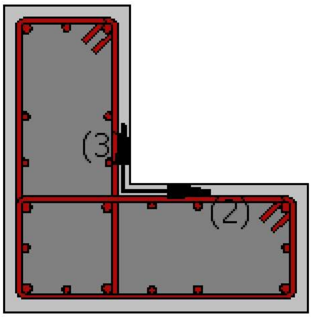
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)





Start Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
###
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
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 = -639020.835
Shear Force, Va = 294.5033
EDGE -B-
Bending Moment, Mb = -243433.419
Shear Force, Vb = -294.5033
BOTH EDGES
Axial Force, F = -9834.091
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL,ten = 17.25

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 474293.501
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 474293.501
VCol = 474293.501
knl = 1.00
displacement_ductility_demand = 0.00739639

NOTE: In expression (10-3) 'Vs' 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 = 639020.835
Vu = 294.5033
d = 0.8*h = 480.00
Nu = 9834.091
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 534070.751
where:
Vs1 = 376991.118 is calculated for section web, with:
d = 480.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.20833333
Vs2 = 157079.633 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 398582.298
bw = 250.00

----
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 = 2.8539063E-005
θy = (My*Ls/3)/EIeff = 0.00385851 ((4.29),Biskinis Phd))
My = 2.8727E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 2169.826
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 5.3849E+013
factor = 0.30
Ag = 237500.00
fc' = 33.00
N = 9834.091
Ec*Ig = 1.7950E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.4238311E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 239.763
d = 558.00
ξy = 0.37251172
A = 0.03425475
B = 0.02212674
with pt = 0.01362483
pc = 0.00594538
pv = 0.01439052
N = 9834.091
b = 250.00
δ'' = 0.07706093
Φy_comp = 1.0626579E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.37102564
A = 0.03380052
B = 0.02183272
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.20286715
lb = 300.00
ld = 1478.80
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 = 17.20
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 = 3.14159
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 = 20.00

End Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 3

Integration Section: (a)

Calculation No. 4

column C1, Floor 1

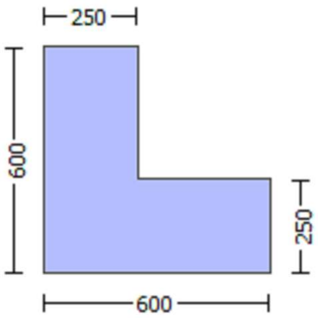
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

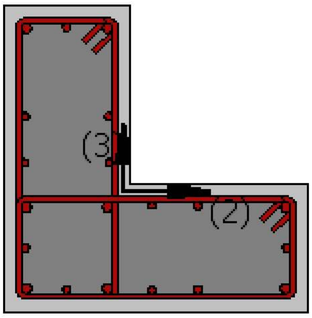
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (3)





Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
###
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.20966
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 = -0.14001342
EDGE -B-
Shear Force, Vb = 0.14001342
BOTH EDGES
Axial Force, F = -8933.736
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 0.47866965
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 260725.615
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9109E+008
Mu1+ = 3.9109E+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- = 1.6345E+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-) = 3.9109E+008
Mu2+ = 3.9109E+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- = 1.6345E+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 = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization

of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00

d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533

ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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)

$\psi t = 1.00$
$\psi s = 0.80$
$\psi e = 1.00$
cb = 25.00
Ktr = 3.14159
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 = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 544688.006

Calculation of Shear Strength at edge 1, Vr1 = 544688.006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 544688.006
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 4.00
Mu = 330.6145
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 418882.372 is calculated for section web, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.20833333
Vs2 = 174534.321 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 631439.816
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 631439.816
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 90.27247
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 418882.372 is calculated for section web, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.20833333
Vs2 = 174534.321 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.20966
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 = -0.14001342
EDGE -B-
Shear Force, Vb = 0.14001342
BOTH EDGES
Axial Force, F = -8933.736
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 0.47866965
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 260725.615
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9109E+008
Mu1+ = 3.9109E+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- = 1.6345E+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-) = 3.9109E+008
Mu2+ = 3.9109E+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- = 1.6345E+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 = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988) "Theoretical Stress-Strain Model for Confined Concrete."

J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005

N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768

with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372

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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00

ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 544688.006

Calculation of Shear Strength at edge 1, Vr1 = 544688.006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 544688.006
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 4.00
Mu = 330.6037
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 174534.321 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.50
Vs2 = 418882.372 is calculated for section flange, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 631439.816
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 631439.816
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 90.28316
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 174534.321 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.50
Vs2 = 418882.372 is calculated for section flange, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
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 = -1.6421E+007
Shear Force, V2 = -5376.74
Shear Force, V3 = 294.5033
Axial Force, F = -9834.091
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL = 17.25

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00543078
θu = θy + θp = 0.00543078

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00543078 ((4.29),Biskinis Phd))
My = 2.8727E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3053.989
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 5.3849E+013
factor = 0.30
Ag = 237500.00
fc' = 33.00
N = 9834.091
Ec*Ig = 1.7950E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.4238311E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 239.763
d = 558.00
ξy = 0.37251172
A = 0.03425475
B = 0.02212674
with pt = 0.01362483
pc = 0.00594538
pv = 0.01439052
N = 9834.091
b = 250.00
δ'' = 0.07706093
Φy_comp = 1.0626579E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.37102564
A = 0.03380052
B = 0.02183272
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.20286715
lb = 300.00
ld = 1478.80
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 = 17.20
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 = 3.14159
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 = 20.00

- 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 = 0.47866965
d = 558.00
s = 0.00
ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = Av*Lstir/(Ag*s) + 2*tf/bw*(ffe/fs) = 0.00
Av = 78.53982, is the area of every stirrup
Lstir = 1460.00, is the total Length of all stirrups parallel to loading (shear) direction
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 = 9834.091
Ag = 237500.00
f'cE = 33.00
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.03396073
b = 250.00
d = 558.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (a)

Calculation No. 5

column C1, Floor 1

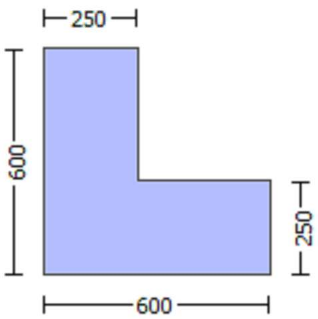
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

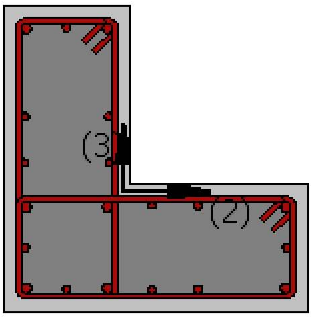
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)





Start Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
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 = -1.6421E+007
Shear Force, Va = -5376.74
EDGE -B-
Bending Moment, Mb = 286361.129
Shear Force, Vb = 5376.74
BOTH EDGES
Axial Force, F = -9834.091
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL,ten = 17.25

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 550004.704
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 550004.704
VCol = 550004.704
knl = 1.00
displacement_ductility_demand = 0.08948864

NOTE: In expression (10-3) 'Vs' 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 = 286361.129
Vu = 5376.74
d = 0.8*h = 480.00
Nu = 9834.091
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 534070.751
where:
Vs1 = 157079.633 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.50
Vs2 = 376991.118 is calculated for section flange, with:
d = 480.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 398582.298
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 = 4.7740181E-005
θy = (My*Ls/3)/EIeff = 0.00053348 ((4.29),Biskinis Phd))
My = 2.8727E+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 = 5.3849E+013
factor = 0.30
Ag = 237500.00
fc' = 33.00
N = 9834.091
Ec*Ig = 1.7950E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.4238311E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 239.763
d = 558.00
ξy = 0.37251172
A = 0.03425475
B = 0.02212674
with pt = 0.01362483
pc = 0.00594538
pv = 0.01439052
N = 9834.091
b = 250.00
δ'' = 0.07706093
Φy_comp = 1.0626579E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.37102564
A = 0.03380052
B = 0.02183272
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.20286715
lb = 300.00
ld = 1478.80
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 = 17.20
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 = 3.14159
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 = 20.00

End Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 6

column C1, Floor 1

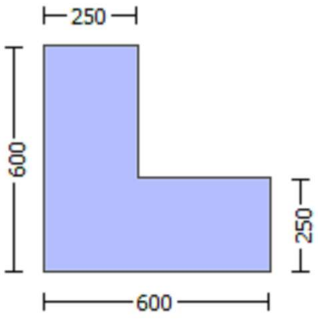
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

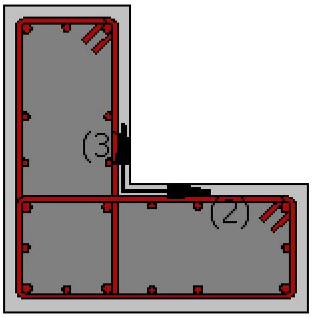
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (2)





Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
###
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.20966
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 = -0.14001342
EDGE -B-
Shear Force, Vb = 0.14001342
BOTH EDGES
Axial Force, F = -8933.736
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 0.47866965
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 260725.615
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9109E+008
Mu1+ = 3.9109E+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- = 1.6345E+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-) = 3.9109E+008
Mu2+ = 3.9109E+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- = 1.6345E+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 = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988) "Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and is calculated as the area of core enclosed by the center lines of the perimeter hoops.

Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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.

$\varepsilon y1, \varepsilon sh1, ft1, fy1$, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 258.2768
with Esv = Es = 200000.00
$\omega 1$ = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
$\omega 2$ = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
$\omega 1$ = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
$\omega 2$ = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
$\varphi u = \varphi su$ (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533

ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 $\varepsilon yv, \varepsilon shv$,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
$\varepsilon y1, \varepsilon sh1$,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 258.2768
with Esv = Es = 200000.00
$\omega 1$ = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
$\omega 2$ = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
$\omega 1$ = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
$\omega 2$ = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
$\varphi u = \varphi su$ (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.6057310E-006

Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 544688.006

Calculation of Shear Strength at edge 1, Vr1 = 544688.006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 544688.006
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 4.00
Mu = 330.6145
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 418882.372 is calculated for section web, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.20833333
Vs2 = 174534.321 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 631439.816
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 631439.816
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 90.27247
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 418882.372 is calculated for section web, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.20833333
Vs2 = 174534.321 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.20966
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 = -0.14001342
EDGE -B-
Shear Force, Vb = 0.14001342
BOTH EDGES
Axial Force, F = -8933.736
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 0.47866965
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 260725.615
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9109E+008
Mu1+ = 3.9109E+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- = 1.6345E+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-) = 3.9109E+008
Mu2+ = 3.9109E+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- = 1.6345E+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 = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988) "Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and is calculated by reducing all the dimensions of the area Aconf,max by a length equal to half the clear spacing between hoops.

AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00

ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373

ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:

b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768

with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 544688.006

Calculation of Shear Strength at edge 1, Vr1 = 544688.006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 544688.006
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 4.00
Mu = 330.6037
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 174534.321 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.50
Vs2 = 418882.372 is calculated for section flange, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 631439.816
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 631439.816
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 90.28316
Vu = 0.14001342
d = 0.8*h = 480.00

Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 174534.321 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.50
Vs2 = 418882.372 is calculated for section flange, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
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 = -243433.419
Shear Force, V2 = 5376.74
Shear Force, V3 = -294.5033
Axial Force, F = -9834.091
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00

-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL = 17.25

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00146989
θu = θy + θp = 0.00146989

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00146989 ((4.29),Biskinis Phd))
My = 2.8727E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 826.5898
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 5.3849E+013
factor = 0.30
Ag = 237500.00
fc' = 33.00
N = 9834.091
Ec*Ig = 1.7950E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.4238311E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 239.763
d = 558.00
ξy = 0.37251172
A = 0.03425475
B = 0.02212674
with pt = 0.01362483
pc = 0.00594538
pv = 0.01439052
N = 9834.091
b = 250.00
δ'' = 0.07706093
Φy_comp = 1.0626579E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.37102564
A = 0.03380052
B = 0.02183272
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.20286715
lb = 300.00
ld = 1478.80
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 = 17.20
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 = 3.14159
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 = 20.00

- 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 = 0.47866965
d = 558.00
s = 0.00
ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = Av*Lstir/(Ag*s) + 2*tf/bw*(ffe/fs) = 0.00
Av = 78.53982, is the area of every stirrup
Lstir = 1460.00, is the total Length of all stirrups parallel to loading (shear) direction
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 = 9834.091
Ag = 237500.00
f'cE = 33.00
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.03396073
b = 250.00
d = 558.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 7

column C1, Floor 1

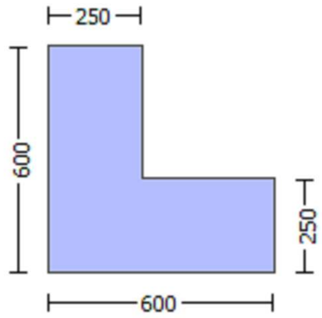
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

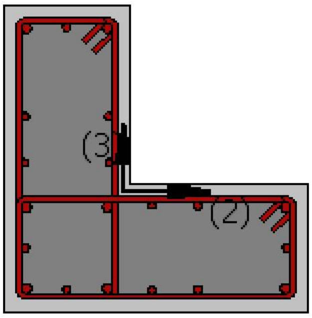
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)





Start Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
###
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
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 = -639020.835
Shear Force, Va = 294.5033
EDGE -B-
Bending Moment, Mb = -243433.419
Shear Force, Vb = -294.5033
BOTH EDGES
Axial Force, F = -9834.091
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664

-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL,ten = 17.25

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 550004.704
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 550004.704
VCol = 550004.704
knl = 1.00
displacement_ductility_demand = 2.1759871E-005

NOTE: In expression (10-3) 'Vs' 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 = 243433.419
Vu = 294.5033
d = 0.8*h = 480.00
Nu = 9834.091
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 534070.751
where:
Vs1 = 376991.118 is calculated for section web, with:
d = 480.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.20833333
Vs2 = 157079.633 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 398582.298
bw = 250.00

----
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 = 3.1984624E-008
θy = (My*Ls/3)/EIeff = 0.00146989 ((4.29),Biskinis Phd))
My = 2.8727E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 826.5898
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 5.3849E+013
factor = 0.30
Ag = 237500.00
fc' = 33.00
N = 9834.091
Ec*Ig = 1.7950E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.4238311E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 239.763
d = 558.00
ξy = 0.37251172
A = 0.03425475
B = 0.02212674
with pt = 0.01362483
pc = 0.00594538
pv = 0.01439052
N = 9834.091
b = 250.00
δ'' = 0.07706093
Φy_comp = 1.0626579E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.37102564
A = 0.03380052
B = 0.02183272
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.20286715
lb = 300.00
ld = 1478.80
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 = 17.20
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 = 3.14159
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 = 20.00

End Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (b)

Calculation No. 8

column C1, Floor 1

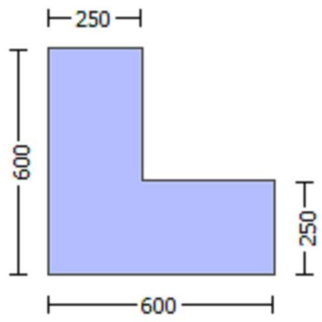
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

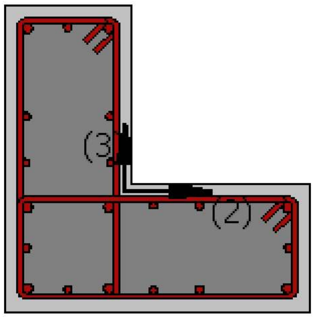
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (3)





Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
###
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.20966
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 = -0.14001342
EDGE -B-
Shear Force, Vb = 0.14001342
BOTH EDGES
Axial Force, F = -8933.736
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 0.47866965
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 260725.615
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9109E+008
Mu1+ = 3.9109E+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- = 1.6345E+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-) = 3.9109E+008
Mu2+ = 3.9109E+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- = 1.6345E+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 = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988) "Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and is calculated by reducing all the dimensions of the area Aconf,max by a length equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813

Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:

b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).

The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372

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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064

N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768

with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322

fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 544688.006

Calculation of Shear Strength at edge 1, Vr1 = 544688.006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 544688.006
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 4.00
Mu = 330.6145
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 418882.372 is calculated for section web, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.20833333
Vs2 = 174534.321 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 631439.816
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 631439.816
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 90.27247
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:

Vs1 = 418882.372 is calculated for section web, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.20833333
Vs2 = 174534.321 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.20966
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 = -0.14001342
EDGE -B-
Shear Force, Vb = 0.14001342

BOTH EDGES
Axial Force, F = -8933.736
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 0.47866965
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 260725.615
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9109E+008
Mu1+ = 3.9109E+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- = 1.6345E+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-) = 3.9109E+008
Mu2+ = 3.9109E+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- = 1.6345E+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 = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988) "Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and is calculated by reducing all the dimensions of the area Aconf,max by a length equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00

fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.

Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533

ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 544688.006

Calculation of Shear Strength at edge 1, Vr1 = 544688.006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 544688.006
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 4.00
Mu = 330.6037
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 174534.321 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.50
Vs2 = 418882.372 is calculated for section flange, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 631439.816
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 631439.816
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 90.28316
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 174534.321 is calculated for section web, with:
d = 200.00
Av = 157079.633

fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.50
Vs2 = 418882.372 is calculated for section flange, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
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 = 286361.129
Shear Force, V2 = 5376.74
Shear Force, V3 = -294.5033
Axial Force, F = -9834.091
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL = 17.25

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00053348
θu = θy + θp = 0.00053348

 - Calculation of θy -

θy = (My*Ls/3)/Eleff = 0.00053348 ((4.29),Biskinis Phd))
   My = 2.8727E+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 = 5.3849E+013
      factor = 0.30
         Ag = 237500.00
         fc' = 33.00
         N = 9834.091
      Ec*Ig = 1.7950E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.4238311E-006
  with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 239.763
      d = 558.00
      ξy = 0.37251172
      A = 0.03425475
      B = 0.02212674
       with pt = 0.01362483
            pc = 0.00594538
            pv = 0.01439052
            N = 9834.091
            b = 250.00
            δ'' = 0.07706093
Φy_comp = 1.0626579E-005
 with fc = 33.00
      Ec = 26999.444
      ξy = 0.37102564
      A = 0.03380052
      B = 0.02183272
       with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.20286715
lb = 300.00
ld = 1478.80
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 = 17.20
   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 = 3.14159
     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 = 20.00

- 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 = 0.47866965
d = 558.00
s = 0.00
ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = Av*Lstir/(Ag*s) + 2*tf/bw*(ffe/fs) = 0.00
Av = 78.53982, is the area of every stirrup
Lstir = 1460.00, is the total Length of all stirrups parallel to loading (shear) direction
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 = 9834.091
Ag = 237500.00
f'cE = 33.00
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.03396073
b = 250.00
d = 558.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (b)

Calculation No. 9

column C1, Floor 1

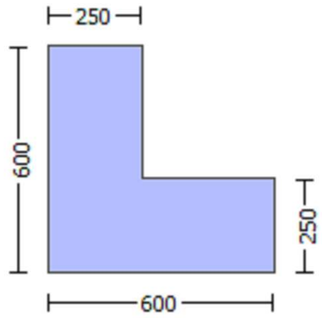
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

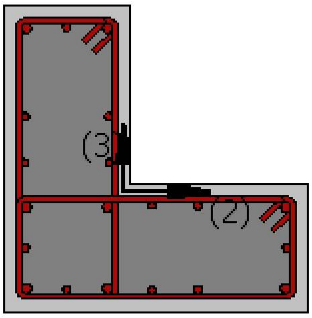
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)





Start Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
###
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
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 = -1.9806E+007
Shear Force, Va = -6485.249
EDGE -B-
Bending Moment, Mb = 345419.632
Shear Force, Vb = 6485.249
BOTH EDGES
Axial Force, F = -10019.72
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664

-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL,ten = 17.25

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 474311.822
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 474311.822
VCol = 474311.822
knl = 1.00
displacement_ductility_demand = 0.02361883

NOTE: In expression (10-3) 'Vs' 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 = 1.9806E+007
Vu = 6485.249
d = 0.8*h = 480.00
Nu = 10019.72
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 534070.751
where:
Vs1 = 157079.633 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.50
Vs2 = 376991.118 is calculated for section flange, with:
d = 480.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 398582.298
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 = 0.00012829
θy = (My*Ls/3)/EIeff = 0.00543147 ((4.29),Biskinis Phd))
My = 2.8731E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3053.992
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 5.3849E+013
factor = 0.30
Ag = 237500.00
fc' = 33.00
N = 10019.72
Ec*Ig = 1.7950E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.4240558E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 239.763
d = 558.00
ξy = 0.37255291
A = 0.0342603
B = 0.02213229
with pt = 0.01362483
pc = 0.00594538
pv = 0.01439052
N = 10019.72
b = 250.00
δ'' = 0.07706093
Φy_comp = 1.0626196E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.37103902
A = 0.03379749
B = 0.02183272
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.20286715
lb = 300.00
ld = 1478.80
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 = 17.20
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 = 3.14159
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 = 20.00

End Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 10

column C1, Floor 1

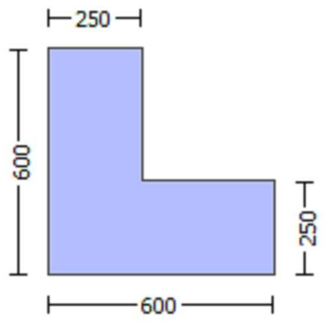
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

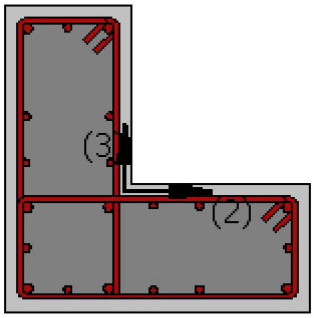
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (2)





Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
###
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.20966
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 = -0.14001342
EDGE -B-
Shear Force, Vb = 0.14001342
BOTH EDGES
Axial Force, F = -8933.736
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 0.47866965
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 260725.615
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9109E+008
Mu1+ = 3.9109E+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- = 1.6345E+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-) = 3.9109E+008
Mu2+ = 3.9109E+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- = 1.6345E+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 = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988) "Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and is calculated by reducing all the dimensions of the area Aconf,max by a length equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813

Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:

b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).

The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372

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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064

N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768

with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322

fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 544688.006

Calculation of Shear Strength at edge 1, Vr1 = 544688.006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 544688.006
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 4.00
Mu = 330.6145
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 418882.372 is calculated for section web, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.20833333
Vs2 = 174534.321 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 631439.816
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 631439.816
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 90.27247
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:

Vs1 = 418882.372 is calculated for section web, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.20833333
Vs2 = 174534.321 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
###
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.20966
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 = -0.14001342
EDGE -B-
Shear Force, Vb = 0.14001342

BOTH EDGES
Axial Force, F = -8933.736
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 0.47866965
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 260725.615
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9109E+008
Mu1+ = 3.9109E+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- = 1.6345E+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-) = 3.9109E+008
Mu2+ = 3.9109E+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- = 1.6345E+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 = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00

fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.

Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533

ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 544688.006

Calculation of Shear Strength at edge 1, Vr1 = 544688.006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 544688.006
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 4.00
Mu = 330.6037
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 174534.321 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.50
Vs2 = 418882.372 is calculated for section flange, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 631439.816
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 631439.816
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 90.28316
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 174534.321 is calculated for section web, with:
d = 200.00
Av = 157079.633

fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.50
Vs2 = 418882.372 is calculated for section flange, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
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 = -770837.742
Shear Force, V2 = -6485.249
Shear Force, V3 = 355.2508
Axial Force, F = -10019.72
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL = 17.25

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.03385903
θu = θy + θp = 0.03385903

 - Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00385903 ((4.29),Biskinis Phd))
My = 2.8731E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 2169.841
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 5.3849E+013
factor = 0.30
Ag = 237500.00
fc' = 33.00
N = 10019.72
Ec*Ig = 1.7950E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.4240558E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 239.763
d = 558.00
ξy = 0.37255291
A = 0.0342603
B = 0.02213229
with pt = 0.01362483
pc = 0.00594538
pv = 0.01439052
N = 10019.72
b = 250.00
δ'' = 0.07706093
Φy_comp = 1.0626196E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.37103902
A = 0.03379749
B = 0.02183272
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.20286715
lb = 300.00
ld = 1478.80
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 = 17.20
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 = 3.14159
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 = 20.00

- 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 = 0.47866965
d = 558.00
s = 0.00
ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = Av*Lstir/(Ag*s) + 2*tf/bw*(ffe/fs) = 0.00
Av = 78.53982, is the area of every stirrup
Lstir = 1460.00, is the total Length of all stirrups parallel to loading (shear) direction
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 = 10019.72
Ag = 237500.00
f'cE = 33.00
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.03396073
b = 250.00
d = 558.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 11

column C1, Floor 1

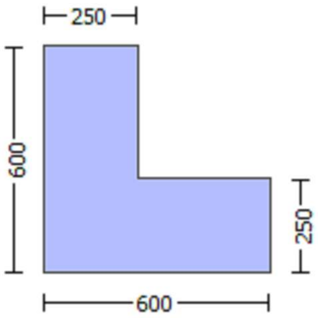
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

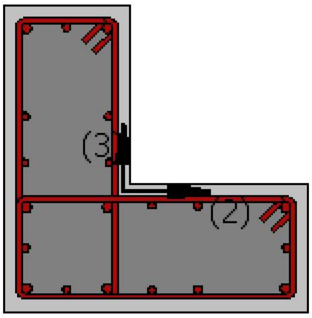
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)





Start Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
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 = -770837.742
Shear Force, Va = 355.2508
EDGE -B-
Bending Moment, Mb = -293641.391
Shear Force, Vb = -355.2508
BOTH EDGES
Axial Force, F = -10019.72
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664

-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL,ten = 17.25

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 474311.822
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 474311.822
VCol = 474311.822
knl = 1.00
displacement_ductility_demand = 0.00891845

NOTE: In expression (10-3) 'Vs' 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 = 770837.742
Vu = 355.2508
d = 0.8*h = 480.00
Nu = 10019.72
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 534070.751
where:
Vs1 = 376991.118 is calculated for section web, with:
d = 480.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.20833333
Vs2 = 157079.633 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 398582.298
bw = 250.00

----
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 = 3.4416526E-005
θy = (My*Ls/3)/EIeff = 0.00385903 ((4.29),Biskinis Phd))
My = 2.8731E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 2169.841
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 5.3849E+013
factor = 0.30
Ag = 237500.00
fc' = 33.00
N = 10019.72
Ec*Ig = 1.7950E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.4240558E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 239.763
d = 558.00
ξy = 0.37255291
A = 0.0342603
B = 0.02213229
with pt = 0.01362483
pc = 0.00594538
pv = 0.01439052
N = 10019.72
b = 250.00
δ" = 0.07706093
Φy_comp = 1.0626196E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.37103902
A = 0.03379749
B = 0.02183272
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.20286715
lb = 300.00
ld = 1478.80
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 = 17.20
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 = 3.14159
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 = 20.00

End Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (a)

Calculation No. 12

column C1, Floor 1

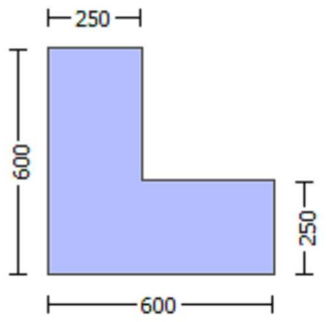
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

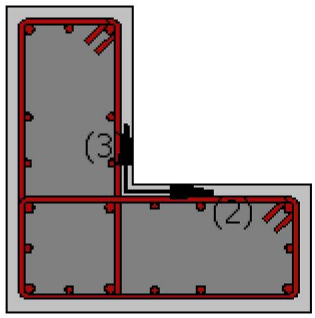
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (3)





Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
###
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.20966
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 = -0.14001342
EDGE -B-
Shear Force, Vb = 0.14001342
BOTH EDGES
Axial Force, F = -8933.736
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 0.47866965
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 260725.615
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9109E+008
Mu1+ = 3.9109E+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- = 1.6345E+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-) = 3.9109E+008
Mu2+ = 3.9109E+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- = 1.6345E+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 = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988) "Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and is calculated by reducing all the dimensions of the area Aconf,max by a length equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813

Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:

b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).

The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372

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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064

N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988) "Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and is calculated by reducing all the dimensions of the area Aconf,max by a length equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768

with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008

----

with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813

----

psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----

psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----

s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322

fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 544688.006

Calculation of Shear Strength at edge 1, Vr1 = 544688.006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 544688.006
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 4.00
Mu = 330.6145
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 418882.372 is calculated for section web, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.20833333
Vs2 = 174534.321 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 631439.816
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 631439.816
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 90.27247
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:

Vs1 = 418882.372 is calculated for section web, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.20833333
Vs2 = 174534.321 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.20966
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 = -0.14001342
EDGE -B-
Shear Force, Vb = 0.14001342

BOTH EDGES
Axial Force, F = -8933.736
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 0.47866965
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 260725.615
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9109E+008
Mu1+ = 3.9109E+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- = 1.6345E+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-) = 3.9109E+008
Mu2+ = 3.9109E+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- = 1.6345E+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 = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----

psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813

Lstir (Length of stirrups along X) = 1460.00

Astir (stirrups area) = 78.53982

Asec (section area) = 237500.00

----

s = 100.00

fywe = 694.45

fce = 33.00

From ((5.A5), TBDY), TBDY: εcc = 0.00409658

λc = confinement factor = 1.20966

εy1 = 0.00092979

εsh1 = 0.00297533

ft1 = 309.9322

fy1 = 258.2768

εsu1 = 0.00297533

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.16229372

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 = 258.2768

with Es1 = Es = 200000.00

εy2 = 0.00092979

εsh2 = 0.00297533

ft2 = 309.9322

fy2 = 258.2768

εsu2 = 0.00297533

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.16229372

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 = 258.2768

with Es2 = Es = 200000.00

εyv = 0.00092979

εshv = 0.00297533

ftv = 309.9322

fyv = 258.2768

εsuv = 0.00297533

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.16229372

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 = 258.2768

with Esv = Es = 200000.00

ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569

ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844

and confined core properties:

b = 190.00

d = 528.00

d' = 13.00

fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.

Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533

ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 544688.006

Calculation of Shear Strength at edge 1, Vr1 = 544688.006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 544688.006
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 4.00
Mu = 330.6037
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 174534.321 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.50
Vs2 = 418882.372 is calculated for section flange, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 631439.816
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 631439.816
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 90.28316
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 174534.321 is calculated for section web, with:
d = 200.00
Av = 157079.633

fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.50
Vs2 = 418882.372 is calculated for section flange, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
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 = -1.9806E+007
Shear Force, V2 = -6485.249
Shear Force, V3 = 355.2508
Axial Force, F = -10019.72
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL = 17.25

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.03543147
θu = θy + θp = 0.03543147

 - Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00543147 ((4.29),Biskinis Phd))
   My = 2.8731E+008
   Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3053.992
   From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 5.3849E+013
      factor = 0.30
         Ag = 237500.00
         fc' = 33.00
         N = 10019.72
      Ec*Ig = 1.7950E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.4240558E-006
  with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 239.763
     d = 558.00
     ξy = 0.37255291
     A = 0.0342603
     B = 0.02213229
      with pt = 0.01362483
         pc = 0.00594538
         pv = 0.01439052
         N = 10019.72
         b = 250.00
         δ'' = 0.07706093
Φy_comp = 1.0626196E-005
 with fc = 33.00
     Ec = 26999.444
     ξy = 0.37103902
     A = 0.03379749
     B = 0.02183272
      with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.20286715
lb = 300.00
ld = 1478.80
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 = 17.20
   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 = 3.14159
     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 = 20.00

- 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 = 0.47866965
d = 558.00
s = 0.00
ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = Av*Lstir/(Ag*s) + 2*tf/bw*(ffe/fs) = 0.00
Av = 78.53982, is the area of every stirrup
Lstir = 1460.00, is the total Length of all stirrups parallel to loading (shear) direction
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 = 10019.72
Ag = 237500.00
f'cE = 33.00
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.03396073
b = 250.00
d = 558.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (a)

Calculation No. 13

column C1, Floor 1

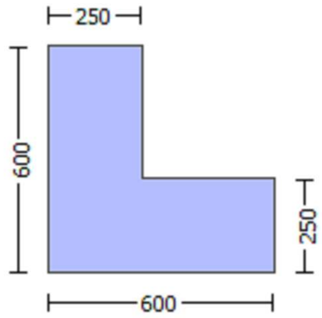
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

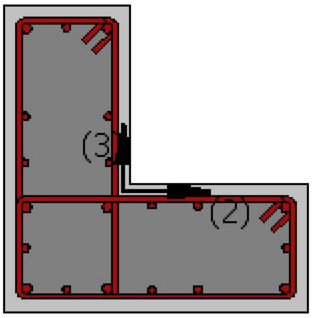
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)





Start Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
###
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
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 = -1.9806E+007
Shear Force, Va = -6485.249
EDGE -B-
Bending Moment, Mb = 345419.632
Shear Force, Vb = 6485.249
BOTH EDGES
Axial Force, F = -10019.72
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664

-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL,ten = 17.25

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 550041.347
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 550041.347
VCol = 550041.347
knl = 1.00
displacement_ductility_demand = 0.10791364

NOTE: In expression (10-3) 'Vs' 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 = 345419.632
Vu = 6485.249
d = 0.8*h = 480.00
Nu = 10019.72
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 534070.751
where:
Vs1 = 157079.633 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.50
Vs2 = 376991.118 is calculated for section flange, with:
d = 480.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 398582.298
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 = 5.7576766E-005
θy = (My*Ls/3)/Eleff = 0.00053354 ((4.29),Biskinis Phd))
My = 2.8731E+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 = 5.3849E+013
factor = 0.30
Ag = 237500.00
fc' = 33.00
N = 10019.72
Ec*Ig = 1.7950E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.4240558E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 239.763
d = 558.00
ξy = 0.37255291
A = 0.0342603
B = 0.02213229
with pt = 0.01362483
pc = 0.00594538
pv = 0.01439052
N = 10019.72
b = 250.00
δ" = 0.07706093
Φy_comp = 1.0626196E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.37103902
A = 0.03379749
B = 0.02183272
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.20286715
lb = 300.00
ld = 1478.80
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 = 17.20
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 = 3.14159
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 = 20.00

End Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 14

column C1, Floor 1

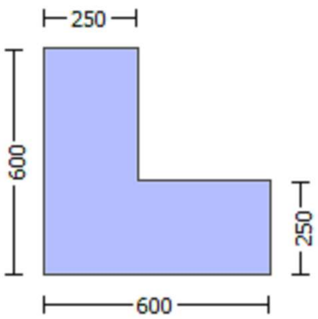
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

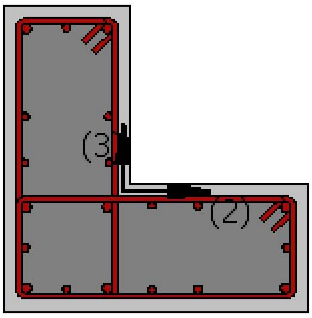
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (2)





Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.20966
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 = -0.14001342
EDGE -B-
Shear Force, Vb = 0.14001342
BOTH EDGES
Axial Force, F = -8933.736
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 0.47866965
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 260725.615
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9109E+008
Mu1+ = 3.9109E+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- = 1.6345E+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-) = 3.9109E+008
Mu2+ = 3.9109E+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- = 1.6345E+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 = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and is calculated by reducing all the dimensions of the area Aconf,max by a length equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813

Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:

b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).

The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372

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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064

N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988) "Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and is calculated by reducing all the dimensions of the area Aconf,max by a length equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768

with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322

fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 544688.006

Calculation of Shear Strength at edge 1, Vr1 = 544688.006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 544688.006
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 4.00
Mu = 330.6145
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 418882.372 is calculated for section web, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.20833333
Vs2 = 174534.321 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 631439.816
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 631439.816
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 90.27247
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:

Vs1 = 418882.372 is calculated for section web, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.20833333
Vs2 = 174534.321 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.20966
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 = -0.14001342
EDGE -B-
Shear Force, Vb = 0.14001342

BOTH EDGES
Axial Force, F = -8933.736
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 0.47866965
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 260725.615
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9109E+008
Mu1+ = 3.9109E+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- = 1.6345E+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-) = 3.9109E+008
Mu2+ = 3.9109E+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- = 1.6345E+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 = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00

fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.

Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533

ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 544688.006

Calculation of Shear Strength at edge 1, Vr1 = 544688.006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 544688.006
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 4.00
Mu = 330.6037
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 174534.321 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.50
Vs2 = 418882.372 is calculated for section flange, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 631439.816
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 631439.816
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 90.28316
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 174534.321 is calculated for section web, with:
d = 200.00
Av = 157079.633

fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.50
Vs2 = 418882.372 is calculated for section flange, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
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 = -293641.391
Shear Force, V2 = 6485.249
Shear Force, V3 = -355.2508
Axial Force, F = -10019.72
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL = 17.25

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.03147005
θu = θy + θp = 0.03147005

 - Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00147005 ((4.29),Biskinis Phd))
  My = 2.8731E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 826.575
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 5.3849E+013
    factor = 0.30
      Ag = 237500.00
      fc' = 33.00
      N = 10019.72
    Ec*Ig = 1.7950E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.4240558E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 239.763
   d = 558.00
   ξy = 0.37255291
   A = 0.0342603
   B = 0.02213229
    with pt = 0.01362483
      pc = 0.00594538
      pv = 0.01439052
      N = 10019.72
      b = 250.00
      δ'' = 0.07706093
Φy_comp = 1.0626196E-005
 with fc = 33.00
   Ec = 26999.444
   ξy = 0.37103902
   A = 0.03379749
   B = 0.02183272
    with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.20286715
lb = 300.00
ld = 1478.80
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 = 17.20
  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 = 3.14159
   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 = 20.00

- 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 = 0.47866965
d = 558.00
s = 0.00
ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = Av*Lstir/(Ag*s) + 2*tf/bw*(ffe/fs) = 0.00
Av = 78.53982, is the area of every stirrup
Lstir = 1460.00, is the total Length of all stirrups parallel to loading (shear) direction
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 = 10019.72
Ag = 237500.00
f'cE = 33.00
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.03396073
b = 250.00
d = 558.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 15

column C1, Floor 1

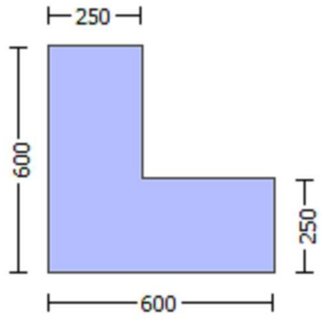
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

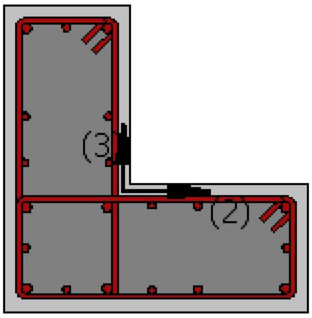
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)





Start Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
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 = -770837.742
Shear Force, Va = 355.2508
EDGE -B-
Bending Moment, Mb = -293641.391
Shear Force, Vb = -355.2508
BOTH EDGES
Axial Force, F = -10019.72
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664

-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL,ten = 17.25

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 550041.347
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 550041.347
VCol = 550041.347
knl = 1.00
displacement_ductility_demand = 2.2063338E-005

NOTE: In expression (10-3) 'Vs' 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 = 293641.391
Vu = 355.2508
d = 0.8*h = 480.00
Nu = 10019.72
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 534070.751
where:
Vs1 = 376991.118 is calculated for section web, with:
d = 480.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.20833333
Vs2 = 157079.633 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 398582.298
bw = 250.00

----
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 = 3.2434197E-008
θy = (My*Ls/3)/Eleff = 0.00147005 ((4.29),Biskinis Phd))
My = 2.8731E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 826.575
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 5.3849E+013
factor = 0.30
Ag = 237500.00
fc' = 33.00
N = 10019.72
Ec*Ig = 1.7950E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.4240558E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 239.763
d = 558.00
ξy = 0.37255291
A = 0.0342603
B = 0.02213229
with pt = 0.01362483
pc = 0.00594538
pv = 0.01439052
N = 10019.72
b = 250.00
δ" = 0.07706093
Φy_comp = 1.0626196E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.37103902
A = 0.03379749
B = 0.02183272
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.20286715
lb = 300.00
ld = 1478.80
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 = 17.20
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 = 3.14159
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 = 20.00

End Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (b)

Calculation No. 16

column C1, Floor 1

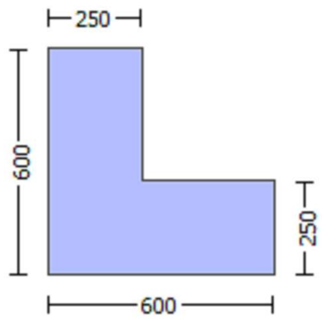
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

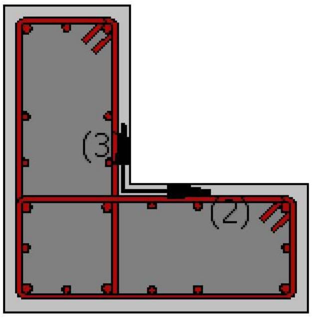
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (3)





Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
###
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.20966
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 = -0.14001342
EDGE -B-
Shear Force, Vb = 0.14001342
BOTH EDGES
Axial Force, F = -8933.736
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 0.47866965
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 260725.615
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9109E+008
Mu1+ = 3.9109E+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- = 1.6345E+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-) = 3.9109E+008
Mu2+ = 3.9109E+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- = 1.6345E+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 = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988) "Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and is calculated by reducing all the dimensions of the area Aconf,max by a length equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813

Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:

b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).

The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372

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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064

N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768

with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322

fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 544688.006

Calculation of Shear Strength at edge 1, Vr1 = 544688.006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 544688.006
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 4.00
Mu = 330.6145
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 418882.372 is calculated for section web, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.20833333
Vs2 = 174534.321 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 631439.816
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 631439.816
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 90.27247
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:

Vs1 = 418882.372 is calculated for section web, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.20833333
Vs2 = 174534.321 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.20966
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 = -0.14001342
EDGE -B-
Shear Force, Vb = 0.14001342

BOTH EDGES
Axial Force, F = -8933.736
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 0.47866965
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 260725.615
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9109E+008
Mu1+ = 3.9109E+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- = 1.6345E+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-) = 3.9109E+008
Mu2+ = 3.9109E+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- = 1.6345E+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 = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988) "Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and is calculated by reducing all the dimensions of the area Aconf,max by a length equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00

fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.

Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.6057310E-006
Mu = 3.9109E+008
----
with full section properties:
b = 250.00
d = 558.00
d' = 43.00
v = 0.00194064
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533

ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.10663569
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04653194
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11262844
and confined core properties:
b = 190.00
d = 528.00
d' = 13.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.14828228
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.064705
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1566155
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
ξsu (4.8) = 0.29893333
Mu = MRc (4.15) = 3.9109E+008
φu = φsu (4.1) = 7.6057310E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.6839732E-006
Mu = 1.6345E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 42.00
v = 0.00081005
N = 8933.736
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01014373
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01014373
ωwe (5.4c) = 0.027587
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00409658
λc = confinement factor = 1.20966
εy1 = 0.00092979
εsh1 = 0.00297533
ft1 = 309.9322
fy1 = 258.2768
εsu1 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Es1 = Es = 200000.00
εy2 = 0.00092979
εsh2 = 0.00297533
ft2 = 309.9322
fy2 = 258.2768
εsu2 = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.16229372
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 = 258.2768
with Es2 = Es = 200000.00
εyv = 0.00092979
εshv = 0.00297533
ftv = 309.9322
fyv = 258.2768
εsuv = 0.00297533
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.16229372
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 = 258.2768
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01942312
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04451131
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04701277
and confined core properties:
b = 540.00
d = 527.00
d' = 12.00
fcc (5A.2, TBDY) = 39.9187
εcc (5A.5, TBDY) = 0.00409658
λc = confinement factor = 1.20966
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.02280977
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0522724
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05521002
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20082004
Mu = MRc (4.14) = 1.6345E+008
φu = φsu (4.1) = 6.6839732E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.16229372
lb = 300.00
ld = 1848.50
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 = 17.20
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 = 3.14159
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 = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 544688.006

Calculation of Shear Strength at edge 1, Vr1 = 544688.006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 544688.006
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 4.00
Mu = 330.6037
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 174534.321 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.50
Vs2 = 418882.372 is calculated for section flange, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 631439.816
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 631439.816
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' 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 = 90.28316
Vu = 0.14001342
d = 0.8*h = 480.00
Nu = 8933.736
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 593416.693
where:
Vs1 = 174534.321 is calculated for section web, with:
d = 200.00
Av = 157079.633

fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.50
Vs2 = 418882.372 is calculated for section flange, with:
d = 480.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 457936.196
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rclcs

Constant Properties

Knowledge Factor, κ = 1.00
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
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
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 = 345419.632
Shear Force, V2 = 6485.249
Shear Force, V3 = -355.2508
Axial Force, F = -10019.72
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 4737.522
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1900.664
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL = 17.25

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.03053354
θu = θy + θp = 0.03053354

- Calculation of θy -

θy = (My*Ls/3)/Eleff = 0.00053354 ((4.29),Biskinis Phd))
My = 2.8731E+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 = 5.3849E+013
factor = 0.30
Ag = 237500.00
fc' = 33.00
N = 10019.72
Ec*Ig = 1.7950E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.4240558E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 239.763
d = 558.00
ξy = 0.37255291
A = 0.0342603
B = 0.02213229
with pt = 0.01362483
pc = 0.00594538
pv = 0.01439052
N = 10019.72
b = 250.00
δ'' = 0.07706093
Φy_comp = 1.0626196E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.37103902
A = 0.03379749
B = 0.02183272
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.20286715
lb = 300.00
ld = 1478.80
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 = 17.20
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 = 3.14159
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 = 20.00

- 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 = 0.47866965
d = 558.00
s = 0.00
ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = Av*Lstir/(Ag*s) + 2*tf/bw*(ffe/fs) = 0.00
Av = 78.53982, is the area of every stirrup
Lstir = 1460.00, is the total Length of all stirrups parallel to loading (shear) direction
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 = 10019.72
Ag = 237500.00
f'cE = 33.00
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.03396073
b = 250.00
d = 558.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (b)
