Detailed Member Calculations

Units: N&mm

Regulation: ASCE 41-17

Calculation No. 1

column C1, Floor 1

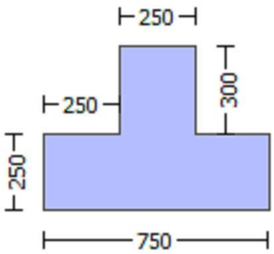
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

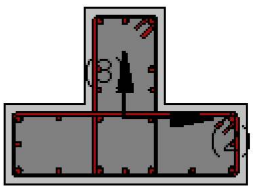
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)





Start Of Calculation of Shear Capacity for element: column TC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 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 = -1.3465E+007
Shear Force, Va = -4401.51
EDGE -B-
Bending Moment, Mb = 257226.284
Shear Force, Vb = 4401.51
BOTH EDGES
Axial Force, F = -10600.461
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2997.079
Mean Diameter of Tension Reinforcement, DbL,ten = 17.60

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 592699.697
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 592699.697
VCol = 592699.697
knl = 1.00
displacement_ductility_demand = 0.0187003

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 = 1.3465E+007
Vu = 4401.51
d = 0.8*h = 600.00
Nu = 10600.461
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 628318.531
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 = 471238.898 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.16666667
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 498227.872
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 = 7.7765188E-005
θy = (My*Ls/3)/EIeff = 0.0041585 ((4.29),Biskinis Phd))
My = 3.0322E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3059.172
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 7.4354E+013
factor = 0.30
Ag = 262500.00
fc' = 33.00
N = 10600.461
Ec*Ig = 2.4785E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.3842088E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 230.3145
d = 707.00
ξy = 0.31683182
A = 0.03115199
B = 0.01664561
with pt = 0.00696749
pc = 0.00696749
pv = 0.0169566
N = 10600.461
b = 250.00
δ'' = 0.06082037
Φy_comp = 9.8788500E-006
with fc = 33.00
Ec = 26999.444
ξy = 0.31499656
A = 0.03075528
B = 0.01638521
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.19099435
lb = 300.00

Id = 1570.727
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
Id,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 = 17.63636
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 = 2.85599
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 = 22.00

End Of Calculation of Shear Capacity for element: column TC1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 2

column C1, Floor 1

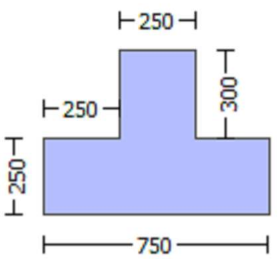
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

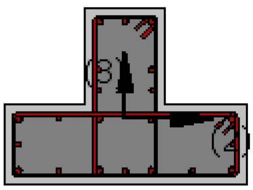
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (2)





Start Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.2478
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 = -0.00014741
EDGE -B-
Shear Force, Vb = 0.00014741
BOTH EDGES
Axial Force, F = -9892.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 2261.947
-Middle: Asl,mid = 2368.761

Calculation of Shear Capacity ratio , Ve/Vr = 0.52825477
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 263845.149
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9577E+008
Mu1+ = 1.4250E+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- = 3.9577E+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-) = 3.9577E+008
Mu2+ = 1.4250E+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- = 3.9577E+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 = 7.0872487E-006
Mu = 1.4250E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00078834
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988

εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01639817
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04472227
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04683416
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01894511
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05166847
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05410837
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20459552
Mu = MRc (4.14) = 1.4250E+008
φu = φsu (4.1) = 7.0872487E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.4602706E-006
Mu = 3.9577E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00236501
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.13416682
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0491945
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14050248
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.18763814
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06880065
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.19649883
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) = 0.33368214
Mu = MRc (4.15) = 3.9577E+008
φu = φsu (4.1) = 8.4602706E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548

lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.0872487E-006
Mu = 1.4250E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00078834
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00

From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01639817
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04472227
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04683416
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01894511
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05166847
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05410837
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->

v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20459552
Mu = MRc (4.14) = 1.4250E+008
φu = φsu (4.1) = 7.0872487E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.4602706E-006
Mu = 3.9577E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00236501
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982

Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.13416682
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0491945
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14050248
and confined core properties:
b = 190.00
d = 477.00

d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.18763814
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06880065
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.19649883
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) = 0.33368214
Mu = MRc (4.15) = 3.9577E+008
φu = φsu (4.1) = 8.4602706E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 499465.716

Calculation of Shear Strength at edge 1, Vr1 = 499465.716
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 499465.716
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 = 481.5174
Vu = 0.00014741
d = 0.8*h = 440.00
Nu = 9892.265
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 558509.829
where:
Vs1 = 383975.507 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 555.56

s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.22727273
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 <= 419774.846
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 499465.716
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 499465.716
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 = 481.5174
Vu = 0.00014741
d = 0.8*h = 440.00
Nu = 9892.265
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 558509.829
where:
Vs1 = 383975.507 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.22727273
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 <= 419774.846
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.2478
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 = -3.6576647E-008
EDGE -B-
Shear Force, Vb = 3.6576647E-008
BOTH EDGES
Axial Force, F = -9892.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2997.079

Calculation of Shear Capacity ratio , Ve/Vr = 0.28998922
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 228815.194
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.4322E+008
Mu1+ = 3.4322E+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- = 3.4322E+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-) = 3.4322E+008
Mu2+ = 3.4322E+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- = 3.4322E+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 = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808

ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008

φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00

Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478

ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 789047.255

Calculation of Shear Strength at edge 1, Vr1 = 789047.255
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 789047.255
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 = 0.27427284
Vu = 3.6576647E-008
d = 0.8*h = 600.00
Nu = 9892.265
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 698137.286
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 = 523602.964 is calculated for section flange, with:
d = 600.00
Av = 157079.633

fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.16666667
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 572420.244
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 789047.255
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 789047.255
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 = 0.27416306
Vu = 3.6576647E-008
d = 0.8*h = 600.00
Nu = 9892.265
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 698137.286
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 = 523602.964 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.16666667
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 572420.244
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column TC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 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 = -345883.184
Shear Force, V2 = -4401.51
Shear Force, V3 = 177.004
Axial Force, F = -10600.461
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 2261.947
-Middle: Asl,mid = 2368.761
Mean Diameter of Tension Reinforcement, DbL = 18.66667

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00245839
θu = θy + θp = 0.00245839

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00245839 ((4.29),Biskinis Phd))
My = 1.7090E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1954.098
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.5281E+013
factor = 0.30
Ag = 262500.00
fc' = 33.00
N = 10600.461
Ec*Ig = 1.5094E+014

Calculation of Yielding Moment My

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

Assuming neutral axis within flange (ξy < t/d, compression zone rectangular) with:
flange width, b = 750.00
web width, bw = 250.00
flange thickness, t = 250.00

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.8893868E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 230.3145
d = 507.00
ξy = 0.21390021
A = 0.01448025

B = 0.00618561
with pt = 0.00218115
pc = 0.00594858
pv = 0.00622948
N = 10600.461
b = 750.00
δ" = 0.08481262
Φy_comp = 2.0468150E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.2120045
A = 0.01429585
B = 0.00606457
with Es = 200000.00
CONFIRMATION: ξy = 0.21261069 < t/d

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.19099435
lb = 300.00
ld = 1570.727
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 = 17.63636
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 = 2.85599
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 = 22.00

- 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/VColOE = 0.52825477
d = 507.00
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 = 1360.00, 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 = 10600.461
Ag = 262500.00
f'cE = 33.00
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.01435921
b = 750.00
d = 507.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column TC1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 3

column C1, Floor 1

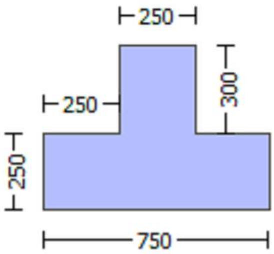
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

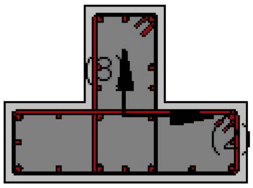
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)





Start Of Calculation of Shear Capacity for element: column TC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00

Eccentricity, Ecc = 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 = -345883.184
Shear Force, Va = 177.004
EDGE -B-
Bending Moment, Mb = -184575.564
Shear Force, Vb = -177.004
BOTH EDGES
Axial Force, F = -10600.461
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 2261.947
-Middle: Asl,mid = 2368.761
Mean Diameter of Tension Reinforcement, DbL,ten = 18.66667

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 434925.408
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 434925.408
VCol = 434925.408
knl = 1.00
displacement_ductility_demand = 0.00556289

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 = 345883.184
Vu = 177.004
d = 0.8*h = 440.00
Nu = 10600.461
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 502654.825
where:
Vs1 = 345575.192 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.22727273
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 <= 365367.106
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 = 1.3675714E-005
θy = (My*Ls/3)/EIeff = 0.00245839 ((4.29),Biskinis Phd))
My = 1.7090E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1954.098
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.5281E+013
factor = 0.30
Ag = 262500.00
fc' = 33.00
N = 10600.461
Ec*Ig = 1.5094E+014

Calculation of Yielding Moment My

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

Assuming neutral axis within flange (ξy < t/d, compression zone rectangular) with:
flange width, b = 750.00
web width, bw = 250.00
flange thickness, t = 250.00

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.8893868E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 230.3145
d = 507.00
ξy = 0.21390021
A = 0.01448025
B = 0.00618561
with pt = 0.00218115
pc = 0.00594858
pv = 0.00622948
N = 10600.461
b = 750.00
δ'' = 0.08481262
Φy_comp = 2.0468150E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.2120045
A = 0.01429585
B = 0.00606457
with Es = 200000.00
CONFIRMATION: ξy = 0.21261069 < t/d

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.19099435
lb = 300.00
ld = 1570.727
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 = 17.63636
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 = 2.85599
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 = 22.00

End Of Calculation of Shear Capacity for element: column TC1 of floor 1
At local axis: 3
Integration Section: (a)

Calculation No. 4

column C1, Floor 1

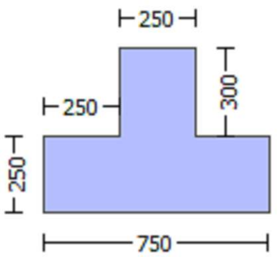
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

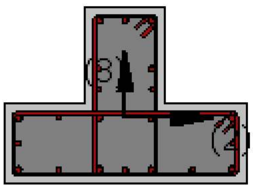
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (3)





Start Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.2478
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 = -0.00014741
EDGE -B-
Shear Force, Vb = 0.00014741
BOTH EDGES
Axial Force, F = -9892.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 2261.947
-Middle: Asl,mid = 2368.761

Calculation of Shear Capacity ratio , Ve/Vr = 0.52825477
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 263845.149
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9577E+008
Mu1+ = 1.4250E+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- = 3.9577E+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-) = 3.9577E+008
Mu2+ = 1.4250E+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- = 3.9577E+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 = 7.0872487E-006
Mu = 1.4250E+008
----

with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00078834
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01639817
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04472227
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04683416
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01894511
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05166847
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05410837
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20459552
Mu = MRc (4.14) = 1.4250E+008
φu = φsu (4.1) = 7.0872487E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.4602706E-006
Mu = 3.9577E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00236501
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00

εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.13416682
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0491945
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14050248
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.18763814
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06880065
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.19649883
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) = 0.33368214
Mu = MRc (4.15) = 3.9577E+008
φu = φsu (4.1) = 8.4602706E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636

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 = 2.85599
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 = 22.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.0872487E-006
Mu = 1.4250E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00078834
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988

εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01639817
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04472227
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04683416
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01894511
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05166847
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05410837
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20459552
Mu = MRc (4.14) = 1.4250E+008
φu = φsu (4.1) = 7.0872487E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.4602706E-006
Mu = 3.9577E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00236501
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00

----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.13416682
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0491945
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14050248
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.18763814
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06880065

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.19649883
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) = 0.33368214
Mu = MRc (4.15) = 3.9577E+008
φu = φsu (4.1) = 8.4602706E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 499465.716

Calculation of Shear Strength at edge 1, Vr1 = 499465.716
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 499465.716
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 = 481.5174
Vu = 0.00014741
d = 0.8*h = 440.00
Nu = 9892.265
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 558509.829
where:
Vs1 = 383975.507 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.22727273
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 <= 419774.846
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 499465.716
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 499465.716
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 = 481.5174
Vu = 0.00014741
d = 0.8*h = 440.00
Nu = 9892.265
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 558509.829
where:
Vs1 = 383975.507 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.22727273
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 <= 419774.846
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.2478
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 = -3.6576647E-008
EDGE -B-
Shear Force, Vb = 3.6576647E-008
BOTH EDGES
Axial Force, F = -9892.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2997.079

Calculation of Shear Capacity ratio , Ve/Vr = 0.28998922
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 228815.194
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.4322E+008
Mu1+ = 3.4322E+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- = 3.4322E+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-) = 3.4322E+008
Mu2+ = 3.4322E+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- = 3.4322E+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 = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00

d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808

ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548

lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00

From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->

v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 789047.255

Calculation of Shear Strength at edge 1, Vr1 = 789047.255
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 789047.255
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 = 0.27427284
Vu = 3.6576647E-008
d = 0.8*h = 600.00
Nu = 9892.265
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 698137.286
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 = 523602.964 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.16666667
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 572420.244

bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 789047.255
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 789047.255
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 = 0.27416306
Vu = 3.6576647E-008
d = 0.8*h = 600.00
Nu = 9892.265
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 698137.286
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 = 523602.964 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.16666667
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 572420.244
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column TC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 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 = -1.3465E+007
Shear Force, V2 = -4401.51
Shear Force, V3 = 177.004
Axial Force, F = -10600.461
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2997.079
Mean Diameter of Tension Reinforcement, DbL = 17.60

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.0041585
θu = θy + θp = 0.0041585

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.0041585 ((4.29),Biskinis Phd))
My = 3.0322E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3059.172
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 7.4354E+013
factor = 0.30
Ag = 262500.00
fc' = 33.00
N = 10600.461
Ec*Ig = 2.4785E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.3842088E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 230.3145
d = 707.00
ξy = 0.31683182
A = 0.03115199
B = 0.01664561
with pt = 0.00696749
pc = 0.00696749
pv = 0.0169566
N = 10600.461
b = 250.00
δ'' = 0.06082037
Φy_comp = 9.8788500E-006
with fc = 33.00
Ec = 26999.444
ξy = 0.31499656

A = 0.03075528
B = 0.01638521
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.19099435
lb = 300.00
ld = 1570.727
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 = 17.63636
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 = 2.85599
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 = 22.00

- 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 = 0.28998922
d = 707.00
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 = 1760.00, 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 = 10600.461
Ag = 262500.00
f'cE = 33.00
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.03089159
b = 250.00
d = 707.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column TC1 of floor 1
At local axis: 3
Integration Section: (a)

Calculation No. 5

column C1, Floor 1

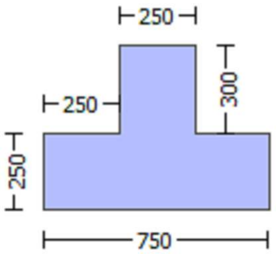
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

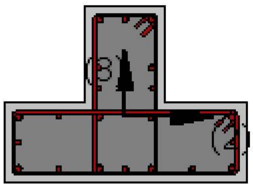
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)





Start Of Calculation of Shear Capacity for element: column TC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 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 = -1.3465E+007
Shear Force, Va = -4401.51
EDGE -B-
Bending Moment, Mb = 257226.284
Shear Force, Vb = 4401.51
BOTH EDGES
Axial Force, F = -10600.461
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2997.079
Mean Diameter of Tension Reinforcement, DbL,ten = 17.60

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 687171.522
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 687171.522
VCol = 687171.522
knl = 1.00
displacement_ductility_demand = 0.06897363

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 = 257226.284
Vu = 4401.51
d = 0.8*h = 600.00
Nu = 10600.461
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 628318.531
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 = 471238.898 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.16666667
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 498227.872
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 = 2.8127887E-005
θy = (My*Ls/3)/Eleff = 0.00040781 ((4.29),Biskinis Phd))
My = 3.0322E+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 = 7.4354E+013
factor = 0.30
Ag = 262500.00
fc' = 33.00
N = 10600.461
Ec*Ig = 2.4785E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.3842088E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 230.3145
d = 707.00
ξy = 0.31683182
A = 0.03115199
B = 0.01664561
with pt = 0.00696749
pc = 0.00696749
pv = 0.0169566
N = 10600.461
b = 250.00
δ'' = 0.06082037
Φy_comp = 9.8788500E-006
with fc = 33.00
Ec = 26999.444
ξy = 0.31499656
A = 0.03075528
B = 0.01638521
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.19099435
lb = 300.00
ld = 1570.727
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 = 17.63636
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 = 2.85599
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 = 22.00

End Of Calculation of Shear Capacity for element: column TC1 of floor 1

At local axis: 2
Integration Section: (b)

Calculation No. 6

column C1, Floor 1

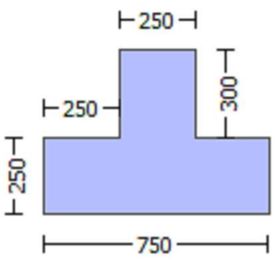
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

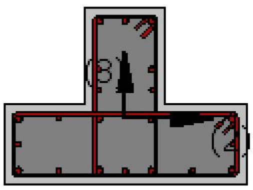
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (2)





Start Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00

Mean Confinement Factor overall section = 1.2478
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 = -0.00014741
EDGE -B-
Shear Force, Vb = 0.00014741
BOTH EDGES
Axial Force, F = -9892.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 2261.947
-Middle: Asl,mid = 2368.761

Calculation of Shear Capacity ratio , Ve/Vr = 0.52825477
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 263845.149
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9577E+008
Mu1+ = 1.4250E+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- = 3.9577E+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-) = 3.9577E+008
Mu2+ = 1.4250E+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- = 3.9577E+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 = 7.0872487E-006
Mu = 1.4250E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00078834
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312

ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01639817
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04472227
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04683416
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01894511
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05166847
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05410837
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20459552
Mu = MRc (4.14) = 1.4250E+008
φu = φsu (4.1) = 7.0872487E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.4602706E-006
Mu = 3.9577E+008
----
with full section properties:
b = 250.00

d = 507.00
d' = 43.00
v = 0.00236501
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.13416682
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0491945
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14050248
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.18763814
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06880065
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.19649883
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) = 0.33368214
Mu = MRc (4.15) = 3.9577E+008
φu = φsu (4.1) = 8.4602706E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.0872487E-006
Mu = 1.4250E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00078834
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00

εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01639817
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04472227
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04683416
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01894511
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05166847
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05410837
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20459552
Mu = MRc (4.14) = 1.4250E+008
φu = φsu (4.1) = 7.0872487E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.4602706E-006
Mu = 3.9577E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00236501
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu^* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
$\varepsilon y1$ = 0.00089315
$\varepsilon sh1$ = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
$\varepsilon su1$ = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.13416682
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0491945
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14050248
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.18763814
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06880065
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.19649883
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) = 0.33368214
Mu = MRc (4.15) = 3.9577E+008
φu = φsu (4.1) = 8.4602706E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 499465.716

Calculation of Shear Strength at edge 1, Vr1 = 499465.716
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 499465.716
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 = 481.5174
Vu = 0.00014741
d = 0.8*h = 440.00
Nu = 9892.265
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 558509.829
where:
Vs1 = 383975.507 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.22727273
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 <= 419774.846
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 499465.716
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 499465.716

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 = 481.5174
Vu = 0.00014741
d = 0.8*h = 440.00
Nu = 9892.265
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 558509.829
where:
Vs1 = 383975.507 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.22727273
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 <= 419774.846
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.2478
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 = -3.6576647E-008
EDGE -B-
Shear Force, Vb = 3.6576647E-008
BOTH EDGES
Axial Force, F = -9892.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2997.079

Calculation of Shear Capacity ratio , Ve/Vr = 0.28998922
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 228815.194
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.4322E+008
Mu1+ = 3.4322E+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- = 3.4322E+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-) = 3.4322E+008
Mu2+ = 3.4322E+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- = 3.4322E+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 = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00

v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988

εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409

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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 789047.255

Calculation of Shear Strength at edge 1, Vr1 = 789047.255
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 789047.255
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 = 0.27427284
Vu = 3.6576647E-008
d = 0.8*h = 600.00
Nu = 9892.265
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 698137.286
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 = 523602.964 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.16666667
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 572420.244
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 789047.255
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 789047.255
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 = 0.27416306
Vu = 3.6576647E-008
d = 0.8*h = 600.00
Nu = 9892.265
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 698137.286
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 = 523602.964 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.16666667
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 572420.244
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column TC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 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 = -184575.564
Shear Force, V2 = 4401.51
Shear Force, V3 = -177.004
Axial Force, F = -10600.461
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 2261.947
-Middle: Asl,mid = 2368.761
Mean Diameter of Tension Reinforcement, DbL = 18.66667

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00131188
θu = θy + θp = 0.00131188

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00131188 ((4.29),Biskinis Phd))
My = 1.7090E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1042.776
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.5281E+013
factor = 0.30
Ag = 262500.00
fc' = 33.00
N = 10600.461
Ec*Ig = 1.5094E+014

Calculation of Yielding Moment My

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

Assuming neutral axis within flange (ξy < t/d, compression zone rectangular) with:
flange width, b = 750.00
web width, bw = 250.00
flange thickness, t = 250.00

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.8893868E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 230.3145
d = 507.00
ξy = 0.21390021
A = 0.01448025
B = 0.00618561
with pt = 0.00218115
pc = 0.00594858
pv = 0.00622948
N = 10600.461
b = 750.00
δ'' = 0.08481262
Φy_comp = 2.0468150E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.2120045
A = 0.01429585
B = 0.00606457
with Es = 200000.00
CONFIRMATION: ξy = 0.21261069 < t/d

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.19099435
lb = 300.00
ld = 1570.727
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 = 17.63636
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 = 2.85599
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 = 22.00

- 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 = 0.52825477
d = 507.00
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 = 1360.00, 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 = 10600.461
Ag = 262500.00
f'cE = 33.00
fytE = fylE = 0.00
ρl = Area_Tot_Long_Rein/(b*d) = 0.01435921
b = 750.00
d = 507.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column TC1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 7

column C1, Floor 1

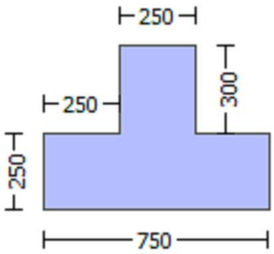
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

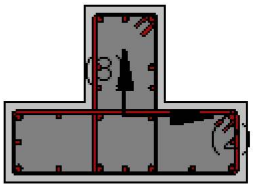
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)





Start Of Calculation of Shear Capacity for element: column TC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 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 = -345883.184
Shear Force, Va = 177.004
EDGE -B-
Bending Moment, Mb = -184575.564
Shear Force, Vb = -177.004
BOTH EDGES
Axial Force, F = -10600.461
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 2261.947
-Middle: Asl,mid = 2368.761
Mean Diameter of Tension Reinforcement, DbL,ten = 18.66667

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 482767.769
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 482767.769
VCol = 482767.769
knl = 1.00
displacement_ductility_demand = 9.2837555E-006

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 = 2.36995
Mu = 184575.564
Vu = 177.004
d = 0.8*h = 440.00
Nu = 10600.461
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 502654.825
where:
Vs1 = 345575.192 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.22727273
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 <= 365367.106
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 = 1.2179189E-008
θy = (My*Ls/3)/EIeff = 0.00131188 ((4.29),Biskinis Phd))

My = 1.7090E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1042.776
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.5281E+013
factor = 0.30
Ag = 262500.00
fc' = 33.00
N = 10600.461
Ec*Ig = 1.5094E+014

Calculation of Yielding Moment My

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

Assuming neutral axis within flange (ξy < t/d, compression zone rectangular) with:
flange width, b = 750.00
web width, bw = 250.00
flange thickness, t = 250.00

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.8893868E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 230.3145
d = 507.00
ξy = 0.21390021
A = 0.01448025
B = 0.00618561
with pt = 0.00218115
pc = 0.00594858
pv = 0.00622948
N = 10600.461
b = 750.00
δ'' = 0.08481262
Φy_comp = 2.0468150E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.2120045
A = 0.01429585
B = 0.00606457
with Es = 200000.00
CONFIRMATION: ξy = 0.21261069 < t/d

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.19099435
lb = 300.00
ld = 1570.727
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 = 17.63636
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 = 2.85599
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 = 22.00

End Of Calculation of Shear Capacity for element: column TC1 of floor 1
At local axis: 3

Integration Section: (b)

Calculation No. 8

column C1, Floor 1

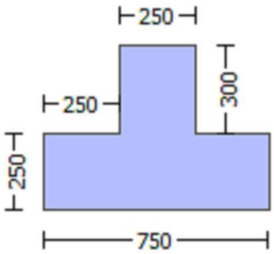
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

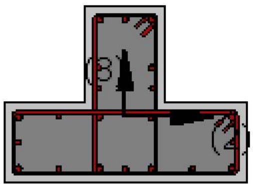
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (3)





Start Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.2478

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 = -0.00014741
EDGE -B-
Shear Force, Vb = 0.00014741
BOTH EDGES
Axial Force, F = -9892.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 2261.947
-Middle: Asl,mid = 2368.761

Calculation of Shear Capacity ratio , Ve/Vr = 0.52825477
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 263845.149
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9577E+008
Mu1+ = 1.4250E+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- = 3.9577E+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-) = 3.9577E+008
Mu2+ = 1.4250E+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- = 3.9577E+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 = 7.0872487E-006
Mu = 1.4250E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00078834
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528

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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01639817
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04472227
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04683416
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01894511
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05166847
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05410837
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20459552
Mu = MRc (4.14) = 1.4250E+008
φu = φsu (4.1) = 7.0872487E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.4602706E-006
Mu = 3.9577E+008
----
with full section properties:
b = 250.00
d = 507.00

d' = 43.00
v = 0.00236501
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.13416682
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0491945
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14050248
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.18763814
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06880065
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.19649883
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) = 0.33368214
Mu = MRc (4.15) = 3.9577E+008
φu = φsu (4.1) = 8.4602706E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.0872487E-006
Mu = 1.4250E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00078834
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315

εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01639817
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04472227
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04683416
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01894511
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05166847
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05410837
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20459552
Mu = MRc (4.14) = 1.4250E+008
φu = φsu (4.1) = 7.0872487E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.4602706E-006
Mu = 3.9577E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00236501
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.13416682
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0491945
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14050248
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.18763814
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06880065
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.19649883
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) = 0.33368214
Mu = MRc (4.15) = 3.9577E+008
φu = φsu (4.1) = 8.4602706E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 499465.716

Calculation of Shear Strength at edge 1, Vr1 = 499465.716
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 499465.716
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 = 481.5174
Vu = 0.00014741
d = 0.8*h = 440.00
Nu = 9892.265
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 558509.829
where:
Vs1 = 383975.507 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.22727273
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 <= 419774.846
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 499465.716
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 499465.716
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 = 481.5174
Vu = 0.00014741
d = 0.8*h = 440.00
Nu = 9892.265
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 558509.829
where:
Vs1 = 383975.507 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.22727273
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 <= 419774.846
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.2478
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 = -3.6576647E-008
EDGE -B-
Shear Force, Vb = 3.6576647E-008
BOTH EDGES
Axial Force, F = -9892.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2997.079

Calculation of Shear Capacity ratio , Ve/Vr = 0.28998922
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 228815.194
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.4322E+008
Mu1+ = 3.4322E+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- = 3.4322E+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-) = 3.4322E+008
Mu2+ = 3.4322E+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- = 3.4322E+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 = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548

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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599

N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988

with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599

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 = 22.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 789047.255

Calculation of Shear Strength at edge 1, Vr1 = 789047.255
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 789047.255
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 = 0.27427284
Vu = 3.6576647E-008
d = 0.8*h = 600.00
Nu = 9892.265
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 698137.286
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 = 523602.964 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.16666667
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 572420.244
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 789047.255
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 789047.255
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 = 0.27416306
Vu = 3.6576647E-008
d = 0.8*h = 600.00
Nu = 9892.265
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 698137.286
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 = 523602.964 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.16666667
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 572420.244
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column TC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 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 = 257226.284

Shear Force, V2 = 4401.51
Shear Force, V3 = -177.004
Axial Force, F = -10600.461
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2997.079
Mean Diameter of Tension Reinforcement, DbL = 17.60

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00040781
θu = θy + θp = 0.00040781

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00040781 ((4.29),Biskinis Phd))
My = 3.0322E+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 = 7.4354E+013
factor = 0.30
Ag = 262500.00
fc' = 33.00
N = 10600.461
Ec*Ig = 2.4785E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.3842088E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 230.3145
d = 707.00
ξy = 0.31683182
A = 0.03115199
B = 0.01664561
with pt = 0.00696749
pc = 0.00696749
pv = 0.0169566
N = 10600.461
b = 250.00
δ'' = 0.06082037
Φy_comp = 9.8788500E-006
with fc = 33.00
Ec = 26999.444
ξy = 0.31499656
A = 0.03075528
B = 0.01638521
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.19099435
lb = 300.00
ld = 1570.727
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 = 17.63636
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 = 2.85599
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 = 22.00

- 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 = 0.28998922
d = 707.00
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 = 1760.00, 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 = 10600.461
Ag = 262500.00
f'cE = 33.00
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.03089159
b = 250.00
d = 707.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column TC1 of floor 1
At local axis: 3
Integration Section: (b)

Calculation No. 9

column C1, Floor 1

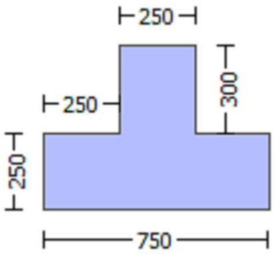
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

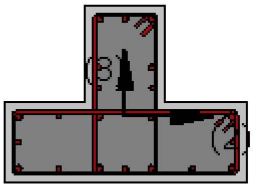
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)





Start Of Calculation of Shear Capacity for element: column TC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 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 = -1.6231E+007
Shear Force, Va = -5305.536
EDGE -B-
Bending Moment, Mb = 310058.054
Shear Force, Vb = 5305.536
BOTH EDGES
Axial Force, F = -10745.918
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2997.079
Mean Diameter of Tension Reinforcement, DbL,ten = 17.60

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 592714.079
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 592714.079
VCol = 592714.079
knl = 1.00
displacement_ductility_demand = 0.02253842

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 = 1.6231E+007
Vu = 5305.536
d = 0.8*h = 600.00
Nu = 10745.918
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 628318.531
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 = 471238.898 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.16666667
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 498227.872
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 = 9.3737383E-005
θy = (My*Ls/3)/EIeff = 0.004159 ((4.29),Biskinis Phd))

My = 3.0326E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3059.172
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 7.4354E+013
factor = 0.30
Ag = 262500.00
fc' = 33.00
N = 10745.918
Ec*Ig = 2.4785E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.3843241E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 230.3145
d = 707.00
ξy = 0.31686484
A = 0.03115556
B = 0.01664919
with pt = 0.00696749
pc = 0.00696749
pv = 0.0169566
N = 10745.918
b = 250.00
δ'' = 0.06082037
Φy_comp = 9.8785978E-006
with fc = 33.00
Ec = 26999.444
ξy = 0.3150046
A = 0.03075341
B = 0.01638521
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.19099435
lb = 300.00
ld = 1570.727
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 = 17.63636
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 = 2.85599
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 = 22.00

End Of Calculation of Shear Capacity for element: column TC1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 10

column C1, Floor 1

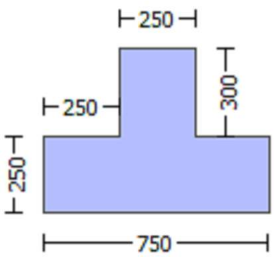
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

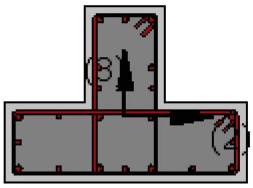
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (2)





Start Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.2478
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 = -0.00014741
EDGE -B-
Shear Force, Vb = 0.00014741
BOTH EDGES
Axial Force, F = -9892.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 2261.947
-Middle: Asl,mid = 2368.761

Calculation of Shear Capacity ratio , Ve/Vr = 0.52825477
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 263845.149
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9577E+008
Mu1+ = 1.4250E+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- = 3.9577E+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-) = 3.9577E+008
Mu2+ = 1.4250E+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- = 3.9577E+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 = 7.0872487E-006
Mu = 1.4250E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00078834
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01639817
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04472227
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04683416
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01894511
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05166847
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05410837
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20459552
Mu = MRc (4.14) = 1.4250E+008
φu = φsu (4.1) = 7.0872487E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.4602706E-006
Mu = 3.9577E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00236501
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071

The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186

fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.13416682
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0491945
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14050248
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.18763814
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06880065
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.19649883
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) = 0.33368214
Mu = MRc (4.15) = 3.9577E+008
φu = φsu (4.1) = 8.4602706E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2+

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

φu = 7.0872487E-006
Mu = 1.4250E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00078834
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01639817
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04472227
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04683416
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01894511
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05166847
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05410837
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20459552
Mu = MRc (4.14) = 1.4250E+008
φu = φsu (4.1) = 7.0872487E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.4602706E-006
Mu = 3.9577E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00236501
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.13416682
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0491945
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14050248
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.18763814
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06880065
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.19649883
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) = 0.33368214
Mu = MRc (4.15) = 3.9577E+008
φu = φsu (4.1) = 8.4602706E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 499465.716

Calculation of Shear Strength at edge 1, Vr1 = 499465.716
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 499465.716
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 = 481.5174
Vu = 0.00014741
d = 0.8*h = 440.00
Nu = 9892.265
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 558509.829
where:
Vs1 = 383975.507 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.22727273
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 <= 419774.846
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 499465.716
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 499465.716
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 = 481.5174
Vu = 0.00014741
d = 0.8*h = 440.00
Nu = 9892.265
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 558509.829
where:
Vs1 = 383975.507 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.22727273
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 <= 419774.846
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.2478
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 = -3.6576647E-008
EDGE -B-
Shear Force, Vb = 3.6576647E-008
BOTH EDGES
Axial Force, F = -9892.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2997.079

Calculation of Shear Capacity ratio , Ve/Vr = 0.28998922
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 228815.194
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.4322E+008
Mu1+ = 3.4322E+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- = 3.4322E+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-) = 3.4322E+008
Mu2+ = 3.4322E+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- = 3.4322E+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 = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071

ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:

b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315

εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 789047.255

Calculation of Shear Strength at edge 1, Vr1 = 789047.255
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 789047.255
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 = 0.27427284
Vu = 3.6576647E-008
d = 0.8*h = 600.00
Nu = 9892.265
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 698137.286
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 = 523602.964 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.16666667
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 572420.244
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 789047.255
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 789047.255
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 = 0.27416306
Vu = 3.6576647E-008
d = 0.8*h = 600.00
Nu = 9892.265
Ag = 187500.00

From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 698137.286
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 = 523602.964 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.16666667
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 572420.244
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column TC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 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 = -416825.242
Shear Force, V2 = -5305.536
Shear Force, V3 = 213.3589
Axial Force, F = -10745.918
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088

Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 2261.947
-Middle: Asl,mid = 2368.761
Mean Diameter of Tension Reinforcement, DbL = 18.66667

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.02862291
θu = θy + θp = 0.02862291

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00245825 ((4.29),Biskinis Phd))
My = 1.7093E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1953.634
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.5281E+013
factor = 0.30
Ag = 262500.00
fc' = 33.00
N = 10745.918
Ec*Ig = 1.5094E+014

Calculation of Yielding Moment My

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

Assuming neutral axis within flange (ξy < t/d, compression zone rectangular) with:
flange width, b = 750.00
web width, bw = 250.00
flange thickness, t = 250.00

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.8894975E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 230.3145
d = 507.00
ξy = 0.21393032
A = 0.01448191
B = 0.00618727
with pt = 0.00218115
pc = 0.00594858
pv = 0.00622948
N = 10745.918
b = 750.00
δ'' = 0.08481262
Φy_comp = 2.0467735E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.21200879
A = 0.01429498
B = 0.00606457
with Es = 200000.00
CONFIRMATION: ξy = 0.21262327 < t/d

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.19099435
lb = 300.00
ld = 1570.727
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 = 17.63636
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 = 2.85599
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 = 22.00

- Calculation of θp -

From table 10-8: θp = 0.02616466
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.52825477
d = 507.00
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 = 1360.00, 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 = 10745.918
Ag = 262500.00
f'cE = 33.00
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.01435921
b = 750.00
d = 507.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column TC1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 11

column C1, Floor 1

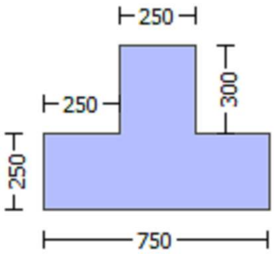
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

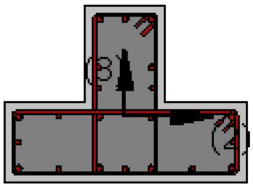
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)





Start Of Calculation of Shear Capacity for element: column TC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 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 = -416825.242
Shear Force, Va = 213.3589
EDGE -B-
Bending Moment, Mb = -222584.443
Shear Force, Vb = -213.3589
BOTH EDGES
Axial Force, F = -10745.918
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 2261.947
-Middle: Asl,mid = 2368.761
Mean Diameter of Tension Reinforcement, DbL,ten = 18.66667

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 434939.732
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 434939.732
VCol = 434939.732
knl = 1.00
displacement_ductility_demand = 0.00670707

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 = 416825.242
Vu = 213.3589
d = 0.8*h = 440.00
Nu = 10745.918
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 502654.825
where:
Vs1 = 345575.192 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.22727273
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 <= 365367.106
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 = 1.6487630E-005
θy = (My*Ls/3)/EIeff = 0.00245825 ((4.29),Biskinis Phd))

My = 1.7093E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1953.634
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.5281E+013
factor = 0.30
Ag = 262500.00
fc' = 33.00
N = 10745.918
Ec*Ig = 1.5094E+014

Calculation of Yielding Moment My

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

Assuming neutral axis within flange (ξy < t/d, compression zone rectangular) with:
flange width, b = 750.00
web width, bw = 250.00
flange thickness, t = 250.00

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.8894975E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 230.3145
d = 507.00
ξy = 0.21393032
A = 0.01448191
B = 0.00618727
with pt = 0.00218115
pc = 0.00594858
pv = 0.00622948
N = 10745.918
b = 750.00
δ'' = 0.08481262
Φy_comp = 2.0467735E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.21200879
A = 0.01429498
B = 0.00606457
with Es = 200000.00
CONFIRMATION: ξy = 0.21262327 < t/d

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.19099435
lb = 300.00
ld = 1570.727
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 = 17.63636
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 = 2.85599
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 = 22.00

End Of Calculation of Shear Capacity for element: column TC1 of floor 1
At local axis: 3

Integration Section: (a)

Calculation No. 12

column C1, Floor 1

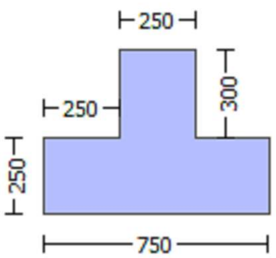
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

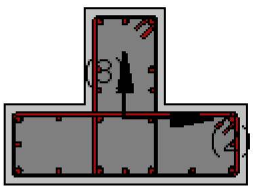
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (3)





Start Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.2478

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 = -0.00014741
EDGE -B-
Shear Force, Vb = 0.00014741
BOTH EDGES
Axial Force, F = -9892.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 2261.947
-Middle: Asl,mid = 2368.761

Calculation of Shear Capacity ratio , Ve/Vr = 0.52825477
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 263845.149
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9577E+008
Mu1+ = 1.4250E+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- = 3.9577E+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-) = 3.9577E+008
Mu2+ = 1.4250E+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- = 3.9577E+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 = 7.0872487E-006
Mu = 1.4250E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00078834
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528

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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01639817
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04472227
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04683416
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01894511
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05166847
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05410837
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20459552
Mu = MRc (4.14) = 1.4250E+008
φu = φsu (4.1) = 7.0872487E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.4602706E-006
Mu = 3.9577E+008
----
with full section properties:
b = 250.00
d = 507.00

d' = 43.00
v = 0.00236501
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.13416682
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0491945
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14050248
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.18763814
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06880065
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.19649883
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) = 0.33368214
Mu = MRc (4.15) = 3.9577E+008
φu = φsu (4.1) = 8.4602706E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.0872487E-006
Mu = 1.4250E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00078834
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315

εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01639817
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04472227
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04683416
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01894511
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05166847
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05410837
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20459552
Mu = MRc (4.14) = 1.4250E+008
φu = φsu (4.1) = 7.0872487E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.4602706E-006
Mu = 3.9577E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00236501
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.13416682
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0491945
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14050248
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.18763814
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06880065
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.19649883
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) = 0.33368214
Mu = MRc (4.15) = 3.9577E+008
φu = φsu (4.1) = 8.4602706E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 499465.716

Calculation of Shear Strength at edge 1, Vr1 = 499465.716
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 499465.716
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 = 481.5174
Vu = 0.00014741
d = 0.8*h = 440.00
Nu = 9892.265
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 558509.829
where:
Vs1 = 383975.507 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.22727273
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 <= 419774.846
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 499465.716
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 499465.716
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 = 481.5174
Vu = 0.00014741
d = 0.8*h = 440.00
Nu = 9892.265
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 558509.829
where:
Vs1 = 383975.507 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.22727273
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 <= 419774.846
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.2478
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 = -3.6576647E-008
EDGE -B-
Shear Force, Vb = 3.6576647E-008
BOTH EDGES
Axial Force, F = -9892.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2997.079

Calculation of Shear Capacity ratio , Ve/Vr = 0.28998922
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 228815.194
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.4322E+008
Mu1+ = 3.4322E+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- = 3.4322E+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-) = 3.4322E+008
Mu2+ = 3.4322E+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- = 3.4322E+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 = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548

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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599

N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988

with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599

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 = 22.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 789047.255

Calculation of Shear Strength at edge 1, Vr1 = 789047.255
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 789047.255
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 = 0.27427284
Vu = 3.6576647E-008
d = 0.8*h = 600.00
Nu = 9892.265
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 698137.286
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 = 523602.964 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.16666667
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 572420.244
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 789047.255
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 789047.255
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 = 0.27416306
Vu = 3.6576647E-008
d = 0.8*h = 600.00
Nu = 9892.265
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 698137.286
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 = 523602.964 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.16666667
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 572420.244
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column TC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 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 = -1.6231E+007

Shear Force, V2 = -5305.536
Shear Force, V3 = 213.3589
Axial Force, F = -10745.918
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2997.079
Mean Diameter of Tension Reinforcement, DbL = 17.60

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.034159
θu = θy + θp = 0.034159

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.004159 ((4.29),Biskinis Phd))
My = 3.0326E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3059.172
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 7.4354E+013
factor = 0.30
Ag = 262500.00
fc' = 33.00
N = 10745.918
Ec*Ig = 2.4785E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.3843241E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 230.3145
d = 707.00
ξy = 0.31686484
A = 0.03115556
B = 0.01664919
with pt = 0.00696749
pc = 0.00696749
pv = 0.0169566
N = 10745.918
b = 250.00
δ'' = 0.06082037
Φy_comp = 9.8785978E-006
with fc = 33.00
Ec = 26999.444
ξy = 0.3150046
A = 0.03075341
B = 0.01638521
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.19099435
lb = 300.00
ld = 1570.727
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 = 17.63636
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 = 2.85599
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 = 22.00

- 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 = 0.28998922
d = 707.00
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 = 1760.00, 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 = 10745.918
Ag = 262500.00
f'cE = 33.00
fytE = fylE = 0.00
ρl = Area_Tot_Long_Rein/(b*d) = 0.03089159
b = 250.00
d = 707.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column TC1 of floor 1
At local axis: 3
Integration Section: (a)

Calculation No. 13

column C1, Floor 1

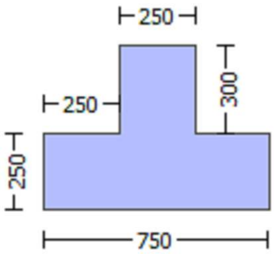
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

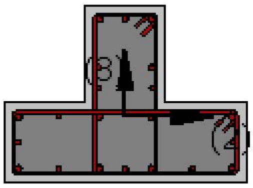
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)





Start Of Calculation of Shear Capacity for element: column TC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 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 = -1.6231E+007
Shear Force, Va = -5305.536
EDGE -B-
Bending Moment, Mb = 310058.054
Shear Force, Vb = 5305.536
BOTH EDGES
Axial Force, F = -10745.918
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2997.079
Mean Diameter of Tension Reinforcement, DbL,ten = 17.60

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 687200.287
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 687200.287
VCol = 687200.287
knl = 1.00
displacement_ductility_demand = 0.08313004

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 = 310058.054
Vu = 5305.536
d = 0.8*h = 600.00
Nu = 10745.918
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 628318.531
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 = 471238.898 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.16666667
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 498227.872
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 = 3.3905077E-005
θy = (My*Ls/3)/EIeff = 0.00040786 ((4.29),Biskinis Phd))

My = 3.0326E+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 = 7.4354E+013
factor = 0.30
Ag = 262500.00
fc' = 33.00
N = 10745.918
Ec*Ig = 2.4785E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.3843241E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 230.3145
d = 707.00
ξy = 0.31686484
A = 0.03115556
B = 0.01664919
with pt = 0.00696749
pc = 0.00696749
pv = 0.0169566
N = 10745.918
b = 250.00
δ'' = 0.06082037
Φy_comp = 9.8785978E-006
with fc = 33.00
Ec = 26999.444
ξy = 0.3150046
A = 0.03075341
B = 0.01638521
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.19099435
lb = 300.00
ld = 1570.727
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 = 17.63636
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 = 2.85599
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 = 22.00

End Of Calculation of Shear Capacity for element: column TC1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 14

column C1, Floor 1

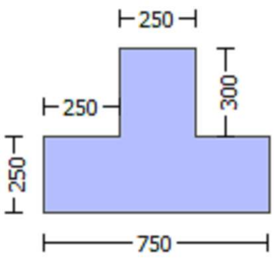
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

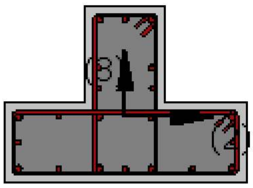
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (2)





Start Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.2478
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 = -0.00014741
EDGE -B-
Shear Force, Vb = 0.00014741
BOTH EDGES
Axial Force, F = -9892.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 2261.947
-Middle: Asl,mid = 2368.761

Calculation of Shear Capacity ratio , Ve/Vr = 0.52825477
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 263845.149
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9577E+008
Mu1+ = 1.4250E+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- = 3.9577E+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-) = 3.9577E+008
Mu2+ = 1.4250E+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- = 3.9577E+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 = 7.0872487E-006
Mu = 1.4250E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00078834
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01639817
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04472227
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04683416
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01894511
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05166847
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05410837
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20459552
Mu = MRc (4.14) = 1.4250E+008
φu = φsu (4.1) = 7.0872487E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.4602706E-006
Mu = 3.9577E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00236501
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071

The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186

fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.13416682
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0491945
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14050248
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.18763814
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06880065
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.19649883
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) = 0.33368214
Mu = MRc (4.15) = 3.9577E+008
φu = φsu (4.1) = 8.4602706E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2+

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

φu = 7.0872487E-006
Mu = 1.4250E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00078834
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01639817
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04472227
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04683416
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01894511
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05166847
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05410837
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20459552
Mu = MRc (4.14) = 1.4250E+008
φu = φsu (4.1) = 7.0872487E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.4602706E-006
Mu = 3.9577E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00236501
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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.

$\varepsilon y1, \varepsilon sh1, ft1, fy1$, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 248.0988
with Es1 = Es = 200000.00
$\varepsilon y2$ = 0.00089315
$\varepsilon sh2$ = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
$\varepsilon su2$ = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
$\varepsilon su2$ = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and $\varepsilon y2, \varepsilon sh2$,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, 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 fs2 = fs = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
$\omega 1$ = Asl,ten/(b*d)*(fs1/fc) = 0.13416682
$\omega 2$ = Asl,com/(b*d)*(fs2/fc) = 0.0491945
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14050248
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
$\omega 1$ = Asl,ten/(b*d)*(fs1/fc) = 0.18763814
$\omega 2$ = Asl,com/(b*d)*(fs2/fc) = 0.06880065
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.19649883
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) = 0.33368214
Mu = MRc (4.15) = 3.9577E+008
$\varphi u = \varphi su$ (4.1) = 8.4602706E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 499465.716

Calculation of Shear Strength at edge 1, Vr1 = 499465.716
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 499465.716
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 = 481.5174
Vu = 0.00014741
d = 0.8*h = 440.00
Nu = 9892.265
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 558509.829
where:
Vs1 = 383975.507 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.22727273
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 <= 419774.846
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 499465.716
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 499465.716
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 = 481.5174
Vu = 0.00014741
d = 0.8*h = 440.00
Nu = 9892.265
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 558509.829
where:
Vs1 = 383975.507 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.22727273
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 <= 419774.846
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.2478
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 = -3.6576647E-008
EDGE -B-
Shear Force, Vb = 3.6576647E-008
BOTH EDGES
Axial Force, F = -9892.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2997.079

Calculation of Shear Capacity ratio , Ve/Vr = 0.28998922
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 228815.194
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.4322E+008
Mu1+ = 3.4322E+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- = 3.4322E+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-) = 3.4322E+008
Mu2+ = 3.4322E+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- = 3.4322E+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 = 5.3520994E-006
Mu = 3.4322E+008

----

with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071

ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:

b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315

εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 789047.255

Calculation of Shear Strength at edge 1, Vr1 = 789047.255
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 789047.255
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 = 0.27427284
Vu = 3.6576647E-008
d = 0.8*h = 600.00
Nu = 9892.265
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 698137.286
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 = 523602.964 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.16666667
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 572420.244
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 789047.255
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 789047.255
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 = 0.27416306
Vu = 3.6576647E-008
d = 0.8*h = 600.00
Nu = 9892.265
Ag = 187500.00

From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 698137.286
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 = 523602.964 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.16666667
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 572420.244
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column TC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 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 = -222584.443
Shear Force, V2 = 5305.536
Shear Force, V3 = -213.3589
Axial Force, F = -10745.918
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088

Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 2261.947
-Middle: Asl,mid = 2368.761
Mean Diameter of Tension Reinforcement, DbL = 18.66667

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.02747736
θu = θy + θp = 0.02747736

- Calculation of θy -

θy = (My*Ls/3)/Eleff = 0.0013127 ((4.29),Biskinis Phd))
My = 1.7093E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1043.24
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 4.5281E+013
factor = 0.30
Ag = 262500.00
fc' = 33.00
N = 10745.918
Ec*Ig = 1.5094E+014

Calculation of Yielding Moment My

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

Assuming neutral axis within flange (ξy < t/d, compression zone rectangular) with:
flange width, b = 750.00
web width, bw = 250.00
flange thickness, t = 250.00

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.8894975E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 230.3145
d = 507.00
ξy = 0.21393032
A = 0.01448191
B = 0.00618727
with pt = 0.00218115
pc = 0.00594858
pv = 0.00622948
N = 10745.918
b = 750.00
δ'' = 0.08481262
Φy_comp = 2.0467735E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.21200879
A = 0.01429498
B = 0.00606457
with Es = 200000.00
CONFIRMATION: ξy = 0.21262327 < t/d

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.19099435
lb = 300.00
ld = 1570.727
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 = 17.63636
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 = 2.85599
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 = 22.00

- Calculation of θp -

From table 10-8: θp = 0.02616466
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.52825477
d = 507.00
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 = 1360.00, 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 = 10745.918
Ag = 262500.00
f'cE = 33.00
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.01435921
b = 750.00
d = 507.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column TC1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 15

column C1, Floor 1

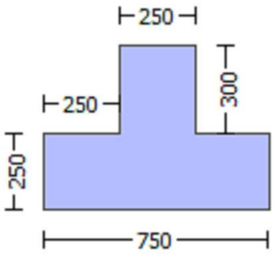
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

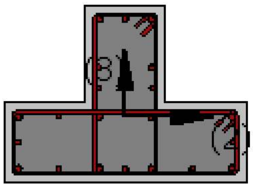
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)





Start Of Calculation of Shear Capacity for element: column TC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 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 = -416825.242
Shear Force, Va = 213.3589
EDGE -B-
Bending Moment, Mb = -222584.443
Shear Force, Vb = -213.3589
BOTH EDGES
Axial Force, F = -10745.918
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 2261.947
-Middle: Asl,mid = 2368.761
Mean Diameter of Tension Reinforcement, DbL,ten = 18.66667

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 482739.787
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 482739.787
VCol = 482739.787
knl = 1.00
displacement_ductility_demand = 8.8520668E-006

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 = 2.371
Mu = 222584.443
Vu = 213.3589
d = 0.8*h = 440.00
Nu = 10745.918
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 502654.825
where:
Vs1 = 345575.192 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.22727273
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 <= 365367.106
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 = 1.1620123E-008
θy = (My*Ls/3)/EIeff = 0.0013127 ((4.29),Biskinis Phd))

My = 1.7093E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1043.24
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.5281E+013
factor = 0.30
Ag = 262500.00
fc' = 33.00
N = 10745.918
Ec*Ig = 1.5094E+014

Calculation of Yielding Moment My

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

Assuming neutral axis within flange (ξy < t/d, compression zone rectangular) with:
flange width, b = 750.00
web width, bw = 250.00
flange thickness, t = 250.00

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.8894975E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 230.3145
d = 507.00
ξy = 0.21393032
A = 0.01448191
B = 0.00618727
with pt = 0.00218115
pc = 0.00594858
pv = 0.00622948
N = 10745.918
b = 750.00
δ'' = 0.08481262
Φy_comp = 2.0467735E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.21200879
A = 0.01429498
B = 0.00606457
with Es = 200000.00
CONFIRMATION: ξy = 0.21262327 < t/d

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.19099435
lb = 300.00
ld = 1570.727
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 = 17.63636
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 = 2.85599
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 = 22.00

End Of Calculation of Shear Capacity for element: column TC1 of floor 1
At local axis: 3

Integration Section: (b)

Calculation No. 16

column C1, Floor 1

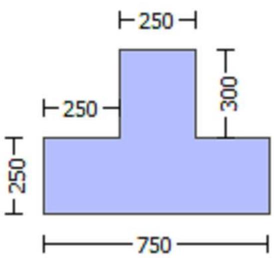
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

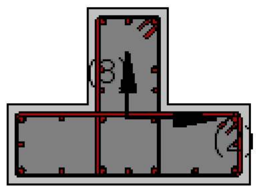
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (3)





Start Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.2478

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 = -0.00014741
EDGE -B-
Shear Force, Vb = 0.00014741
BOTH EDGES
Axial Force, F = -9892.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 2261.947
-Middle: Asl,mid = 2368.761

Calculation of Shear Capacity ratio , Ve/Vr = 0.52825477
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 263845.149
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9577E+008
Mu1+ = 1.4250E+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- = 3.9577E+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-) = 3.9577E+008
Mu2+ = 1.4250E+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- = 3.9577E+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 = 7.0872487E-006
Mu = 1.4250E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00078834
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528

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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01639817
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04472227
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04683416
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01894511
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05166847
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05410837
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20459552
Mu = MRc (4.14) = 1.4250E+008
φu = φsu (4.1) = 7.0872487E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.4602706E-006
Mu = 3.9577E+008
----
with full section properties:
b = 250.00
d = 507.00

d' = 43.00
v = 0.00236501
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.13416682
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0491945
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14050248
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.18763814
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06880065
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.19649883
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) = 0.33368214
Mu = MRc (4.15) = 3.9577E+008
φu = φsu (4.1) = 8.4602706E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.0872487E-006
Mu = 1.4250E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00078834
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315

εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01639817
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04472227
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04683416
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01894511
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05166847
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05410837
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.20459552
Mu = MRc (4.14) = 1.4250E+008
φu = φsu (4.1) = 7.0872487E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.4602706E-006
Mu = 3.9577E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00236501
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.13416682
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.0491945
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14050248
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.18763814
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06880065
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.19649883
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) = 0.33368214
Mu = MRc (4.15) = 3.9577E+008
φu = φsu (4.1) = 8.4602706E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 499465.716

Calculation of Shear Strength at edge 1, Vr1 = 499465.716
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 499465.716
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 = 481.5174
Vu = 0.00014741
d = 0.8*h = 440.00
Nu = 9892.265
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 558509.829
where:
Vs1 = 383975.507 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.22727273
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 <= 419774.846
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 499465.716
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 499465.716
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 = 481.5174
Vu = 0.00014741
d = 0.8*h = 440.00
Nu = 9892.265
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 558509.829
where:
Vs1 = 383975.507 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.22727273
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 <= 419774.846
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.2478
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 = -3.6576647E-008
EDGE -B-
Shear Force, Vb = 3.6576647E-008
BOTH EDGES
Axial Force, F = -9892.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2997.079

Calculation of Shear Capacity ratio , Ve/Vr = 0.28998922
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 228815.194
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.4322E+008
Mu1+ = 3.4322E+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- = 3.4322E+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-) = 3.4322E+008
Mu2+ = 3.4322E+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- = 3.4322E+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 = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548

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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599

N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988

with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599

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 = 22.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 5.3520994E-006
Mu = 3.4322E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00169599
N = 9892.265
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01050071
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01050071
ωwe (5.4c) = 0.0306312
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.35771528
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 = 188100.00 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 = 137025.00 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 = 95733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00406911
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00406911
Lstir (Length of stirrups along Y) = 1360.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00526591
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 100.00
fywe = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00447797
λc = confinement factor = 1.2478
εy1 = 0.00089315
εsh1 = 0.00285808
ft1 = 297.7186
fy1 = 248.0988
εsu1 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Es1 = Es = 200000.00
εy2 = 0.00089315
εsh2 = 0.00285808
ft2 = 297.7186
fy2 = 248.0988
εsu2 = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.15279548
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 = 248.0988
with Es2 = Es = 200000.00
εyv = 0.00089315
εshv = 0.00285808
ftv = 297.7186
fyv = 248.0988
εsuv = 0.00285808
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.15279548
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 = 248.0988
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05238262
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05238262
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1274822
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 41.1773
εcc (5A.5, TBDY) = 0.00447797
λc = confinement factor = 1.2478
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07197877
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07197877
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17517281
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24468157
Mu = MRc (4.14) = 3.4322E+008
φu = φsu (4.1) = 5.3520994E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.15279548
lb = 300.00
ld = 1963.409
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 = 17.63636
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 = 2.85599
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 = 22.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 789047.255

Calculation of Shear Strength at edge 1, Vr1 = 789047.255
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 789047.255
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 = 0.27427284
Vu = 3.6576647E-008
d = 0.8*h = 600.00
Nu = 9892.265
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 698137.286
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 = 523602.964 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.16666667
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 572420.244
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 789047.255
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 789047.255
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 = 0.27416306
Vu = 3.6576647E-008
d = 0.8*h = 600.00
Nu = 9892.265
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 698137.286
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 = 523602.964 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.16666667
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 572420.244
bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column TC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column TC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rctcs

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 = 550.00
Min Height, Hmin = 250.00
Max Width, Wmax = 750.00
Min Width, Wmin = 250.00
Eccentricity, Ecc = 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 = 310058.054

Shear Force, V2 = 5305.536
Shear Force, V3 = -213.3589
Axial Force, F = -10745.918
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5460.088
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2997.079
Mean Diameter of Tension Reinforcement, DbL = 17.60

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.03040786
θu = θy + θp = 0.03040786

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00040786 ((4.29),Biskinis Phd))
My = 3.0326E+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 = 7.4354E+013
factor = 0.30
Ag = 262500.00
fc' = 33.00
N = 10745.918
Ec*Ig = 2.4785E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.3843241E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 230.3145
d = 707.00
ξy = 0.31686484
A = 0.03115556
B = 0.01664919
with pt = 0.00696749
pc = 0.00696749
pv = 0.0169566
N = 10745.918
b = 250.00
δ'' = 0.06082037
Φy_comp = 9.8785978E-006
with fc = 33.00
Ec = 26999.444
ξy = 0.3150046
A = 0.03075341
B = 0.01638521
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.19099435
lb = 300.00
ld = 1570.727
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 = 17.63636
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 = 2.85599
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 = 22.00

- 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 = 0.28998922
d = 707.00
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 = 1760.00, 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 = 10745.918
Ag = 262500.00
f'cE = 33.00
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.03089159
b = 250.00
d = 707.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column TC1 of floor 1
At local axis: 3
Integration Section: (b)
