Detailed Member Calculations

Units: N&mm

Regulation: ASCE 41-17

Calculation No. 1

column C1, Floor 1

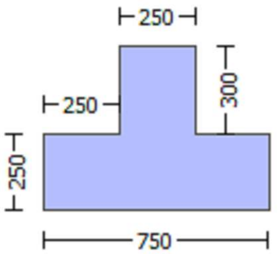
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

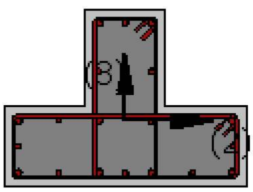
Analysis: Uniform +X

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 Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 28781.504

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 = 37.50
New material: Steel Strength, fs = fsm = 625.00
##
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
Primary 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 = -8.7997E+006
Shear Force, Va = -2853.907
EDGE -B-
Bending Moment, Mb = 235710.829
Shear Force, Vb = 2853.907
BOTH EDGES
Axial Force, F = -10499.307
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2689.203
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 = 513340.842
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 513340.842
VCol = 513340.842
knl = 1.00
displacement_ductility_demand = 0.01222015

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 = 8.7997E+006
Vu = 2853.907
d = 0.8*h = 600.00
Nu = 10499.307
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 418879.02
where:
Vs1 = 104719.755 is calculated for section web, with:
d = 200.00

Av = 157079.633
fy = 500.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.75
Vs2 = 314159.265 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 500.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.25
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 = 4.8165359E-005
θy = (My*Ls/3)/EIeff = 0.00394147 ((4.29),Biskinis Phd))
My = 3.0396E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3083.371
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 7.9262E+013
factor = 0.30
Ag = 262500.00
fc' = 37.50
N = 10499.307
Ec*Ig = 2.6421E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.4323438E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 238.7991
d = 707.00
ξy = 0.30568213
A = 0.02939847
B = 0.01571006
with pt = 0.00696749
pc = 0.00696749
pv = 0.01521473
N = 10499.307
b = 250.00
δ'' = 0.06082037
Φy_comp = 1.0917443E-005
with fc = 37.50
Ec = 28781.504
ξy = 0.3038435
A = 0.02902307
B = 0.01546131
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.16899117
lb = 300.00

ld = 1775.241
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 = 18.00
Mean strength value of all re-bars: fy = 625.00
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

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

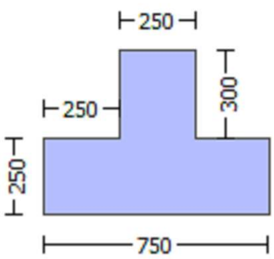
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

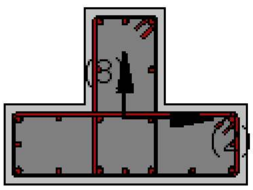
Analysis: Uniform +X

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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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 = 781.25
##
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 = 1.14004
Element Length, L = 3000.00
Primary 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 = 0.00014703
EDGE -B-
Shear Force, Vb = -0.00014703
BOTH EDGES
Axial Force, F = -9867.326
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 2261.947
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2060.885

Calculation of Shear Capacity ratio , Ve/Vr = 0.52496023
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 264455.432
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9668E+008
Mu1+ = 3.9668E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.2114E+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-) = 3.9668E+008
Mu2+ = 3.9668E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.2114E+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 = 7.7193240E-006
Mu = 3.9668E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00207597
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385

εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12241628
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04488597
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11153483
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1712045
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06277498
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.15598632
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) = 0.32694776
Mu = MRc (4.15) = 3.9668E+008
φu = φsu (4.1) = 7.7193240E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.5970839E-006
Mu = 1.2114E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00069199
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01496199
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04080543
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03717828
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01728586
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04714327
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04295275
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.2124538
Mu = MRc (4.14) = 1.2114E+008
φu = φsu (4.1) = 6.5970839E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294

lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.7193240E-006
Mu = 3.9668E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00207597
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50

From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12241628
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04488597
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11153483
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1712045
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06277498
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.15598632
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) = 0.32694776
Mu = MRc (4.15) = 3.9668E+008
φu = φsu (4.1) = 7.7193240E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.5970839E-006
Mu = 1.2114E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00069199
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274

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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01496199
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04080543
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03717828
and confined core properties:

b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01728586
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04714327
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04295275
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.2124538
Mu = MRc (4.14) = 1.2114E+008
φu = φsu (4.1) = 6.5970839E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 503762.797

Calculation of Shear Strength at edge 1, Vr1 = 503762.797
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 503762.797
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
Mu = 788.0877
Vu = 0.00014703
d = 0.8*h = 440.00
Nu = 9867.326
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 418879.02
where:
Vs1 = 287979.327 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 625.00

s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.34090909
Vs2 = 130899.694 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.75
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 447481.489
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 503762.797
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 503762.797
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
Mu = 788.0877
Vu = 0.00014703
d = 0.8*h = 440.00
Nu = 9867.326
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 418879.02
where:
Vs1 = 287979.327 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.34090909
Vs2 = 130899.694 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.75
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 447481.489
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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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 = 781.25
##
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 = 1.14004
Element Length, L = 3000.00
Primary 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 = 3.6907929E-008
EDGE -B-
Shear Force, Vb = -3.6907929E-008
BOTH EDGES
Axial Force, F = -9867.326
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2689.203

Calculation of Shear Capacity ratio , Ve/Vr = 0.29501144
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 222553.55
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.3383E+008
Mu1+ = 3.3383E+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- = 3.3383E+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-) = 3.3383E+008
Mu2+ = 3.3383E+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- = 3.3383E+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 = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006
Mu = 3.3383E+008

----

with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274

----

psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00

----

s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412

ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008

$\varphi u = \varphi su$ (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00

Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004

ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 754389.565

Calculation of Shear Strength at edge 1, Vr1 = 754389.565
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 754389.565
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.45248062
Vu = 3.6907929E-008
d = 0.8*h = 600.00
Nu = 9867.326
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 523598.776
where:
Vs1 = 130899.694 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.75
Vs2 = 392699.082 is calculated for section flange, with:
d = 600.00
Av = 157079.633

fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 610202.031
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 754389.565
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 754389.565
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.45236986
Vu = 3.6907929E-008
d = 0.8*h = 600.00
Nu = 9867.326
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 523598.776
where:
Vs1 = 130899.694 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.75
Vs2 = 392699.082 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 610202.031
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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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
Primary 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 = -330176.506
Shear Force, V2 = -2853.907
Shear Force, V3 = 169.0106
Axial Force, F = -10499.307
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 2261.947
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2060.885
Mean Diameter of Tension Reinforcement, DbL = 17.77778

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00399196
θu = θy + θp = 0.00399196

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00399196 ((4.29),Biskinis Phd))
My = 2.9591E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1953.584
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.8270E+013
factor = 0.30
Ag = 262500.00
fc' = 37.50
N = 10499.307
Ec*Ig = 1.6090E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.9022767E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 238.7991
d = 507.00
ξy = 0.39650081
A = 0.0409955
B = 0.02756681
with pt = 0.01784573
pc = 0.00654344
pv = 0.01625945
N = 10499.307

b = 250.00
δ" = 0.08481262
Φy_comp = 1.1708664E-005
with fc = 37.50
Ec = 28781.504
ξy = 0.39507084
A = 0.04047201
B = 0.02721993
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.16899117
lb = 300.00
ld = 1775.241
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 = 18.00
Mean strength value of all re-bars: fy = 625.00
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

- Calculation of θp -

From table 10-8: θp = 0.00
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.52496023
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 = 10499.307
Ag = 262500.00
f'cE = 37.50
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.04064862
b = 250.00
d = 507.00
f'cE = 37.50

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

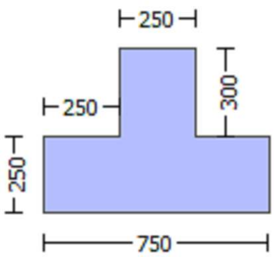
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

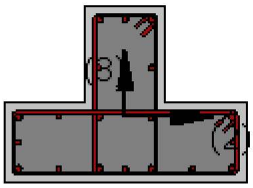
Analysis: Uniform +X

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 Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 28781.504
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 = 37.50
New material: Steel Strength, fs = fsm = 625.00
###
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
Primary 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 = -330176.506
Shear Force, Va = 169.0106
EDGE -B-
Bending Moment, Mb = -176497.263
Shear Force, Vb = -169.0106
BOTH EDGES
Axial Force, F = -10499.307
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 2261.947
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2060.885
Mean Diameter of Tension Reinforcement, DbL,ten = 17.77778

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 404651.555
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 404651.555
VCol = 404651.555
knl = 1.00
displacement_ductility_demand = 0.00199106

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 = 330176.506
Vu = 169.0106
d = 0.8*h = 440.00
Nu = 10499.307
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 335103.216
where:
Vs1 = 230383.461 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 500.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.34090909
Vs2 = 104719.755 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 500.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.75
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 = 7.9482364E-006
θy = (My*Ls/3)/EIeff = 0.00399196 ((4.29),Biskinis Phd))
My = 2.9591E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1953.584
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.8270E+013
factor = 0.30
Ag = 262500.00
fc' = 37.50
N = 10499.307
Ec*Ig = 1.6090E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.9022767E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 238.7991
d = 507.00
ξy = 0.39650081
A = 0.0409955
B = 0.02756681
with pt = 0.01784573
pc = 0.00654344
pv = 0.01625945
N = 10499.307
b = 250.00
δ'' = 0.08481262
Φy_comp = 1.1708664E-005
with fc = 37.50
Ec = 28781.504
ξy = 0.39507084
A = 0.04047201
B = 0.02721993
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.16899117
lb = 300.00
ld = 1775.241
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 = 18.00
Mean strength value of all re-bars: fy = 625.00
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

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

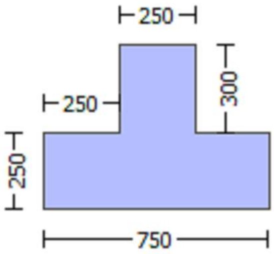
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

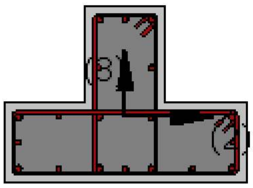
Analysis: Uniform +X

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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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 = 781.25
##
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 = 1.14004
Element Length, L = 3000.00
Primary 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 = 0.00014703
EDGE -B-
Shear Force, Vb = -0.00014703
BOTH EDGES
Axial Force, F = -9867.326
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 2261.947
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2060.885

Calculation of Shear Capacity ratio , Ve/Vr = 0.52496023
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 264455.432
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9668E+008
Mu1+ = 3.9668E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.2114E+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-) = 3.9668E+008
Mu2+ = 3.9668E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.2114E+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 = 7.7193240E-006
Mu = 3.9668E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00207597
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822

ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12241628
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04488597
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11153483
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1712045
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06277498
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.15598632
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) = 0.32694776
Mu = MRc (4.15) = 3.9668E+008
φu = φsu (4.1) = 7.7193240E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.5970839E-006
Mu = 1.2114E+008
----

with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00069199
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01496199
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04080543
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03717828
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01728586
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04714327
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04295275
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.2124538
Mu = MRc (4.14) = 1.2114E+008
φu = φsu (4.1) = 6.5970839E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.7193240E-006
Mu = 3.9668E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00207597
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00

εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12241628
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04488597
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11153483
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1712045
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06277498
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.15598632
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) = 0.32694776
Mu = MRc (4.15) = 3.9668E+008
φu = φsu (4.1) = 7.7193240E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00

Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.5970839E-006
Mu = 1.2114E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00069199
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385

εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01496199
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04080543
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03717828
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01728586
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04714327
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04295275
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.2124538
Mu = MRc (4.14) = 1.2114E+008
φu = φsu (4.1) = 6.5970839E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 503762.797

Calculation of Shear Strength at edge 1, Vr1 = 503762.797
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 503762.797
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
Mu = 788.0877
Vu = 0.00014703
d = 0.8*h = 440.00
Nu = 9867.326
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 418879.02
where:
Vs1 = 287979.327 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.34090909
Vs2 = 130899.694 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.75
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 447481.489
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 503762.797
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 503762.797

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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
Mu = 788.0877
Vu = 0.00014703
d = 0.8*h = 440.00
Nu = 9867.326
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 418879.02
where:
Vs1 = 287979.327 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.34090909
Vs2 = 130899.694 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.75
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 447481.489
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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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 = 781.25
###
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 = 1.14004
Element Length, L = 3000.00

Primary 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 = 3.6907929E-008
EDGE -B-
Shear Force, Vb = -3.6907929E-008
BOTH EDGES
Axial Force, F = -9867.326
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2689.203

Calculation of Shear Capacity ratio , Ve/Vr = 0.29501144
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 222553.55
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.3383E+008
Mu1+ = 3.3383E+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- = 3.3383E+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-) = 3.3383E+008
Mu2+ = 3.3383E+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- = 3.3383E+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 = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00

v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385

εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051

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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 754389.565

Calculation of Shear Strength at edge 1, Vr1 = 754389.565
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 754389.565
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.45248062
Vu = 3.6907929E-008
d = 0.8*h = 600.00
Nu = 9867.326
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 523598.776
where:
Vs1 = 130899.694 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.75
Vs2 = 392699.082 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 610202.031
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 754389.565
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 754389.565
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.45236986
Vu = 3.6907929E-008
d = 0.8*h = 600.00
Nu = 9867.326
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 523598.776
where:
Vs1 = 130899.694 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.75
Vs2 = 392699.082 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 610202.031
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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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
Primary 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 = -8.7997E+006
Shear Force, V2 = -2853.907
Shear Force, V3 = 169.0106
Axial Force, F = -10499.307
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2689.203
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 = 0.00394147
θu = θy + θp = 0.00394147

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00394147 ((4.29),Biskinis Phd))
My = 3.0396E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3083.371
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 7.9262E+013
factor = 0.30
Ag = 262500.00
fc' = 37.50
N = 10499.307
Ec*Ig = 2.6421E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.4323438E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 238.7991
d = 707.00
ξy = 0.30568213
A = 0.02939847
B = 0.01571006
with pt = 0.00696749
pc = 0.00696749
pv = 0.01521473
N = 10499.307
b = 250.00
δ'' = 0.06082037
Φy_comp = 1.0917443E-005
with fc = 37.50
Ec = 28781.504
ξy = 0.3038435
A = 0.02902307
B = 0.01546131
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.16899117
lb = 300.00
ld = 1775.241
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 = 18.00
Mean strength value of all re-bars: fy = 625.00
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

- Calculation of θp -

From table 10-8: θp = 0.00
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.29501144
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 = 10499.307
Ag = 262500.00
f'cE = 37.50
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.02914971
b = 250.00
d = 707.00
f'cE = 37.50

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

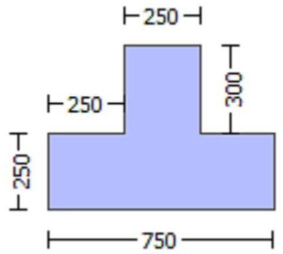
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

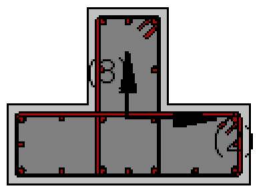
Analysis: Uniform +X

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 Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 28781.504
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 = 37.50
New material: Steel Strength, fs = fsm = 625.00
##
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
Primary 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 = -8.7997E+006
Shear Force, Va = -2853.907
EDGE -B-
Bending Moment, Mb = 235710.829
Shear Force, Vb = 2853.907
BOTH EDGES
Axial Force, F = -10499.307
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2689.203
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 = 607802.664
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 607802.664
VCol = 607802.664
knl = 1.00
displacement_ductility_demand = 0.04559909

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 = 235710.829
Vu = 2853.907
d = 0.8*h = 600.00
Nu = 10499.307
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 418879.02
where:
Vs1 = 104719.755 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 500.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.75
Vs2 = 314159.265 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 500.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.25
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 = 1.7486781E-005
θy = (My*Ls/3)/EIeff = 0.00038349 ((4.29),Biskinis Phd))

My = 3.0396E+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 = 7.9262E+013
factor = 0.30
Ag = 262500.00
fc' = 37.50
N = 10499.307
Ec*Ig = 2.6421E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.4323438E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 238.7991
d = 707.00
ξy = 0.30568213
A = 0.02939847
B = 0.01571006
with pt = 0.00696749
pc = 0.00696749
pv = 0.01521473
N = 10499.307
b = 250.00
δ'' = 0.06082037
Φy_comp = 1.0917443E-005
with fc = 37.50
Ec = 28781.504
ξy = 0.3038435
A = 0.02902307
B = 0.01546131
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.16899117
lb = 300.00
ld = 1775.241
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 = 18.00
Mean strength value of all re-bars: fy = 625.00
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

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

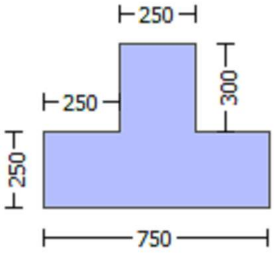
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

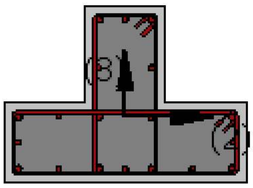
Analysis: Uniform +X

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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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 = 781.25
##
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 = 1.14004
Element Length, L = 3000.00
Primary 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 = 0.00014703
EDGE -B-
Shear Force, Vb = -0.00014703
BOTH EDGES
Axial Force, F = -9867.326
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 2261.947
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2060.885

Calculation of Shear Capacity ratio , Ve/Vr = 0.52496023
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 264455.432
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9668E+008
Mu1+ = 3.9668E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.2114E+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-) = 3.9668E+008
Mu2+ = 3.9668E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.2114E+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 = 7.7193240E-006
Mu = 3.9668E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00207597
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12241628
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04488597
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11153483
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1712045
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06277498
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.15598632
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) = 0.32694776
Mu = MRc (4.15) = 3.9668E+008
φu = φsu (4.1) = 7.7193240E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.5970839E-006
Mu = 1.2114E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00069199
N = 9867.326
fc = 37.50

εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316

εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01496199
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04080543
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03717828
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01728586
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04714327
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04295275
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.2124538
Mu = MRc (4.14) = 1.2114E+008
φu = φsu (4.1) = 6.5970839E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2+

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

φu = 7.7193240E-006
Mu = 3.9668E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00207597
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12241628
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04488597
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11153483
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1712045
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06277498
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.15598632
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) = 0.32694776
Mu = MRc (4.15) = 3.9668E+008
φu = φsu (4.1) = 7.7193240E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944

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 = 150.00
n = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.5970839E-006
Mu = 1.2114E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00069199
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01496199
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04080543
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03717828
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01728586
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04714327
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04295275
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.2124538
Mu = MRc (4.14) = 1.2114E+008
φu = φsu (4.1) = 6.5970839E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 503762.797

Calculation of Shear Strength at edge 1, Vr1 = 503762.797
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 503762.797
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
Mu = 788.0877
Vu = 0.00014703
d = 0.8*h = 440.00
Nu = 9867.326
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 418879.02
where:
Vs1 = 287979.327 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.34090909
Vs2 = 130899.694 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.75
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 447481.489
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 503762.797
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 503762.797
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)

M/Vd = 4.00
Mu = 788.0877
Vu = 0.00014703
d = 0.8*h = 440.00
Nu = 9867.326
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 418879.02
where:
Vs1 = 287979.327 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.34090909
Vs2 = 130899.694 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.75
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 447481.489
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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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 = 781.25
###
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 = 1.14004
Element Length, L = 3000.00
Primary 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 = 3.6907929E-008
EDGE -B-
Shear Force, Vb = -3.6907929E-008
BOTH EDGES
Axial Force, F = -9867.326
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2689.203

Calculation of Shear Capacity ratio , Ve/Vr = 0.29501144
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 222553.55
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.3383E+008
Mu1+ = 3.3383E+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- = 3.3383E+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-) = 3.3383E+008
Mu2+ = 3.3383E+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- = 3.3383E+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 = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501

ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:

b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316

εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 754389.565

Calculation of Shear Strength at edge 1, Vr1 = 754389.565
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 754389.565
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.45248062
Vu = 3.6907929E-008
d = 0.8*h = 600.00
Nu = 9867.326
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 523598.776
where:
Vs1 = 130899.694 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.75
Vs2 = 392699.082 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 610202.031
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 754389.565
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 754389.565
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.45236986
Vu = 3.6907929E-008
d = 0.8*h = 600.00
Nu = 9867.326
Ag = 187500.00

From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 523598.776
where:
Vs1 = 130899.694 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.75
Vs2 = 392699.082 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 610202.031
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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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
Primary 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 = -176497.263
Shear Force, V2 = 2853.907
Shear Force, V3 = -169.0106
Axial Force, F = -10499.307
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212

Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 2261.947
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2060.885
Mean Diameter of Tension Reinforcement, DbL = 17.77778

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00213392
θu = θy + θp = 0.00213392

- Calculation of θy -

θy = (My*Ls/3)/Eleff = 0.00213392 ((4.29),Biskinis Phd))
My = 2.9591E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1044.297
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 4.8270E+013
factor = 0.30
Ag = 262500.00
fc' = 37.50
N = 10499.307
Ec*Ig = 1.6090E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.9022767E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 238.7991
d = 507.00
ξy = 0.39650081
A = 0.0409955
B = 0.02756681
with pt = 0.01784573
pc = 0.00654344
pv = 0.01625945
N = 10499.307
b = 250.00
δ'' = 0.08481262
Φy_comp = 1.1708664E-005
with fc = 37.50
Ec = 28781.504
ξy = 0.39507084
A = 0.04047201
B = 0.02721993
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.16899117
lb = 300.00
ld = 1775.241
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 = 18.00
Mean strength value of all re-bars: fy = 625.00
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

- Calculation of θp -

From table 10-8: θp = 0.00
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.52496023
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 = 10499.307
Ag = 262500.00
f'cE = 37.50
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.04064862
b = 250.00
d = 507.00
f'cE = 37.50

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

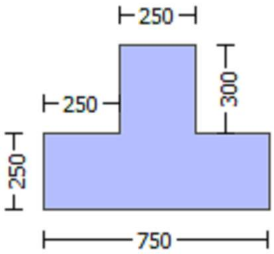
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

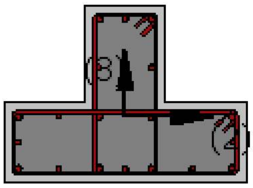
Analysis: Uniform +X

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 Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 28781.504
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 = 37.50
New material: Steel Strength, fs = fsm = 625.00
##
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
Primary 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 = -330176.506
Shear Force, Va = 169.0106
EDGE -B-
Bending Moment, Mb = -176497.263
Shear Force, Vb = -169.0106
BOTH EDGES
Axial Force, F = -10499.307
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten = 2261.947
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2060.885
Mean Diameter of Tension Reinforcement, DbL,ten = 17.77778

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 452316.14
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 452316.14
VCol = 452316.14
knl = 1.00
displacement_ductility_demand = 7.0740911E-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 = 2.3734
Mu = 176497.263
Vu = 169.0106
d = 0.8*h = 440.00
Nu = 10499.307
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 335103.216
where:
Vs1 = 230383.461 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 500.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.34090909
Vs2 = 104719.755 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 500.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.75
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 = 1.5095558E-008
θy = (My*Ls/3)/Eleff = 0.00213392 ((4.29),Biskinis Phd))
My = 2.9591E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1044.297
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 4.8270E+013
factor = 0.30
Ag = 262500.00
fc' = 37.50
N = 10499.307
Ec*Ig = 1.6090E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.9022767E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 238.7991
d = 507.00
ξy = 0.39650081
A = 0.0409955
B = 0.02756681
with pt = 0.01784573
pc = 0.00654344
pv = 0.01625945
N = 10499.307
b = 250.00
δ'' = 0.08481262
Φy_comp = 1.1708664E-005
with fc = 37.50
Ec = 28781.504
ξy = 0.39507084
A = 0.04047201
B = 0.02721993
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.16899117
lb = 300.00
ld = 1775.241
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 = 18.00
Mean strength value of all re-bars: fy = 625.00
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

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

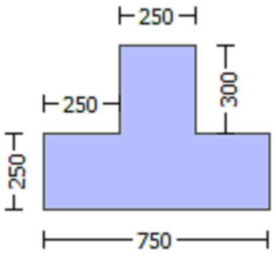
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

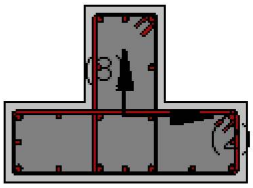
Analysis: Uniform +X

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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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 = 781.25
###
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 = 1.14004
Element Length, L = 3000.00
Primary 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 = 0.00014703
EDGE -B-
Shear Force, Vb = -0.00014703
BOTH EDGES
Axial Force, F = -9867.326
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 2261.947
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2060.885

Calculation of Shear Capacity ratio , Ve/Vr = 0.52496023
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 264455.432
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9668E+008
Mu1+ = 3.9668E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.2114E+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-) = 3.9668E+008
Mu2+ = 3.9668E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.2114E+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 = 7.7193240E-006
Mu = 3.9668E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00207597
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----

psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12241628
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04488597
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11153483

and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1712045
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06277498
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.15598632
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) = 0.32694776
Mu = MRc (4.15) = 3.9668E+008
φu = φsu (4.1) = 7.7193240E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.5970839E-006
Mu = 1.2114E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00069199
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01496199
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04080543
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03717828
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01728586
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04714327
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04295275
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.2124538
Mu = MRc (4.14) = 1.2114E+008
φu = φsu (4.1) = 6.5970839E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.7193240E-006
Mu = 3.9668E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00

v = 0.00207597
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12241628
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04488597
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11153483
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1712045
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06277498
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.15598632
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) = 0.32694776
Mu = MRc (4.15) = 3.9668E+008
φu = φsu (4.1) = 7.7193240E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.5970839E-006
Mu = 1.2114E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00069199
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412

ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01496199
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04080543
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03717828
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01728586
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04714327
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04295275
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.2124538
Mu = MRc (4.14) = 1.2114E+008
φu = φsu (4.1) = 6.5970839E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 503762.797

Calculation of Shear Strength at edge 1, Vr1 = 503762.797
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 503762.797
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
Mu = 788.0877
Vu = 0.00014703
d = 0.8*h = 440.00
Nu = 9867.326
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 418879.02
where:
Vs1 = 287979.327 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.34090909
Vs2 = 130899.694 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.75
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 447481.489
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 503762.797
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 503762.797
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
Mu = 788.0877
Vu = 0.00014703
d = 0.8*h = 440.00
Nu = 9867.326
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 418879.02

where:
Vs1 = 287979.327 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.34090909
Vs2 = 130899.694 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.75
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 447481.489
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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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 = 781.25
##
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 = 1.14004
Element Length, L = 3000.00
Primary 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 = 3.6907929E-008

EDGE -B-
Shear Force, Vb = -3.6907929E-008
BOTH EDGES
Axial Force, F = -9867.326
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2689.203

Calculation of Shear Capacity ratio , Ve/Vr = 0.29501144
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 222553.55
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.3383E+008
Mu1+ = 3.3383E+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- = 3.3383E+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-) = 3.3383E+008
Mu2+ = 3.3383E+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- = 3.3383E+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 = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00

d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412

ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006

Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00

n = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 754389.565

Calculation of Shear Strength at edge 1, Vr1 = 754389.565
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 754389.565
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.45248062
Vu = 3.6907929E-008
d = 0.8*h = 600.00
Nu = 9867.326
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 523598.776
where:
Vs1 = 130899.694 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.75
Vs2 = 392699.082 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 610202.031
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 754389.565
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 754389.565
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.45236986
Vu = 3.6907929E-008
d = 0.8*h = 600.00
Nu = 9867.326
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 523598.776
where:
Vs1 = 130899.694 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00

Vs1 is multiplied by αCol1 = 1.00
s/d = 0.75
Vs2 = 392699.082 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 610202.031
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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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
Primary 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 = 235710.829
Shear Force, V2 = 2853.907
Shear Force, V3 = -169.0106
Axial Force, F = -10499.307
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2689.203
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 = 0.00038349
θu = θy + θp = 0.00038349

 - Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00038349 ((4.29),Biskinis Phd))
 My = 3.0396E+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 = 7.9262E+013
 factor = 0.30
 Ag = 262500.00
 fc' = 37.50
 N = 10499.307
 Ec*Ig = 2.6421E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.4323438E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 238.7991
 d = 707.00
 ξy = 0.30568213
 A = 0.02939847
 B = 0.01571006
 with pt = 0.00696749
 pc = 0.00696749
 pv = 0.01521473
 N = 10499.307
 b = 250.00
 δ'' = 0.06082037
Φy_comp = 1.0917443E-005
 with fc = 37.50
 Ec = 28781.504
 ξy = 0.3038435
 A = 0.02902307
 B = 0.01546131
 with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.16899117
lb = 300.00
ld = 1775.241
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 = 18.00
 Mean strength value of all re-bars: fy = 625.00
 fc' = 37.50, 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 = 2.0944
 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 = 150.00
 n = 20.00

- Calculation of θp -

From table 10-8: θp = 0.00
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.29501144
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 = 10499.307
Ag = 262500.00
f'cE = 37.50
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.02914971
b = 250.00
d = 707.00
f'cE = 37.50

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

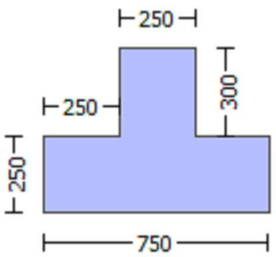
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

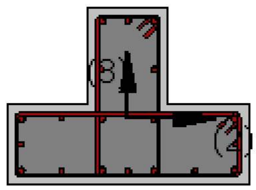
Analysis: Uniform +X

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 Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 28781.504
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 = 37.50
New material: Steel Strength, fs = fsm = 625.00
###
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
Primary 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 = -1.3835E+007
Shear Force, Va = -4487.046
EDGE -B-
Bending Moment, Mb = 370595.336
Shear Force, Vb = 4487.046
BOTH EDGES
Axial Force, F = -10860.955
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2689.203
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 = 513376.601
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 513376.601
VCol = 513376.601
knl = 1.00
displacement_ductility_demand = 0.01920719

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 = 1.3835E+007
Vu = 4487.046
d = 0.8*h = 600.00
Nu = 10860.955
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 418879.02
where:
Vs1 = 104719.755 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 500.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.75
Vs2 = 314159.265 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 500.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.25
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 = 7.5727826E-005
θy = (My*Ls/3)/EIeff = 0.00394268 ((4.29),Biskinis Phd))
My = 3.0405E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3083.371
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 7.9262E+013
factor = 0.30
Ag = 262500.00
fc' = 37.50
N = 10860.955
Ec*Ig = 2.6421E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.4326278E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 238.7991
d = 707.00
ξy = 0.30576318
A = 0.02940704
B = 0.01571863
with pt = 0.00696749
pc = 0.00696749
pv = 0.01521473
N = 10860.955
b = 250.00
δ" = 0.06082037
Φy_comp = 1.0916788E-005
with fc = 37.50
Ec = 28781.504
ξy = 0.30386172
A = 0.02901871
B = 0.01546131
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.16899117
lb = 300.00
ld = 1775.241
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 = 18.00
Mean strength value of all re-bars: fy = 625.00
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

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

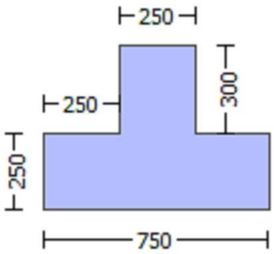
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

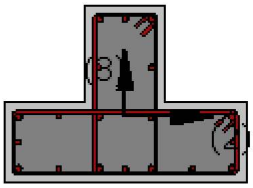
Analysis: Uniform +X

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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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 = 781.25
##
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 = 1.14004
Element Length, L = 3000.00
Primary 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 = 0.00014703
EDGE -B-
Shear Force, Vb = -0.00014703
BOTH EDGES
Axial Force, F = -9867.326
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 2261.947
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2060.885

Calculation of Shear Capacity ratio , Ve/Vr = 0.52496023
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 264455.432
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9668E+008
Mu1+ = 3.9668E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.2114E+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-) = 3.9668E+008
Mu2+ = 3.9668E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.2114E+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 = 7.7193240E-006
Mu = 3.9668E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00207597
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----

psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12241628
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04488597
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11153483

and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1712045
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06277498
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.15598632
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) = 0.32694776
Mu = MRc (4.15) = 3.9668E+008
φu = φsu (4.1) = 7.7193240E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.5970839E-006
Mu = 1.2114E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00069199
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01496199
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04080543
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03717828
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01728586
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04714327
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04295275
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.2124538
Mu = MRc (4.14) = 1.2114E+008
φu = φsu (4.1) = 6.5970839E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.7193240E-006
Mu = 3.9668E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00

v = 0.00207597
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12241628
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04488597
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11153483
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1712045
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06277498
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.15598632
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) = 0.32694776
Mu = MRc (4.15) = 3.9668E+008
φu = φsu (4.1) = 7.7193240E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.5970839E-006
Mu = 1.2114E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00069199
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412

ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01496199
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04080543
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03717828
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01728586
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04714327
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04295275
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.2124538
Mu = MRc (4.14) = 1.2114E+008
φu = φsu (4.1) = 6.5970839E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 503762.797

Calculation of Shear Strength at edge 1, Vr1 = 503762.797
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 503762.797
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
Mu = 788.0877
Vu = 0.00014703
d = 0.8*h = 440.00
Nu = 9867.326
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 418879.02
where:
Vs1 = 287979.327 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.34090909
Vs2 = 130899.694 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.75
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 447481.489
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 503762.797
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 503762.797
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
Mu = 788.0877
Vu = 0.00014703
d = 0.8*h = 440.00
Nu = 9867.326
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 418879.02

where:
Vs1 = 287979.327 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.34090909
Vs2 = 130899.694 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.75
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 447481.489
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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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 = 781.25
###
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 = 1.14004
Element Length, L = 3000.00
Primary 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 = 3.6907929E-008

EDGE -B-
Shear Force, Vb = -3.6907929E-008
BOTH EDGES
Axial Force, F = -9867.326
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2689.203

Calculation of Shear Capacity ratio , Ve/Vr = 0.29501144
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 222553.55
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.3383E+008
Mu1+ = 3.3383E+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- = 3.3383E+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-) = 3.3383E+008
Mu2+ = 3.3383E+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- = 3.3383E+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 = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00

d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412

ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006

Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00

n = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 754389.565

Calculation of Shear Strength at edge 1, Vr1 = 754389.565
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 754389.565
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.45248062
Vu = 3.6907929E-008
d = 0.8*h = 600.00
Nu = 9867.326
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 523598.776
where:
Vs1 = 130899.694 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.75
Vs2 = 392699.082 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 610202.031
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 754389.565
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 754389.565
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.45236986
Vu = 3.6907929E-008
d = 0.8*h = 600.00
Nu = 9867.326
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 523598.776
where:
Vs1 = 130899.694 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00

Vs1 is multiplied by αCol1 = 1.00
s/d = 0.75
Vs2 = 392699.082 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 610202.031
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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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
Primary 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 = -519569.932
Shear Force, V2 = -4487.046
Shear Force, V3 = 265.7264
Axial Force, F = -10860.955
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 2261.947
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2060.885
Mean Diameter of Tension Reinforcement, DbL = 17.77778

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.0292333
θu = θy + θp = 0.0292333

 - Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00399629 ((4.29),Biskinis Phd))
   My = 2.9597E+008
   Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1955.282
   From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.8270E+013
      factor = 0.30
         Ag = 262500.00
         fc' = 37.50
         N = 10860.955
      Ec*Ig = 1.6090E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.9027522E-006
  with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 238.7991
      d = 507.00
      ξy = 0.39657433
      A = 0.04100744
      B = 0.02757875
       with pt = 0.01784573
            pc = 0.00654344
            pv = 0.01625945
            N = 10860.955
            b = 250.00
            δ'' = 0.08481262
Φy_comp = 1.1707932E-005
 with fc = 37.50
      Ec = 28781.504
      ξy = 0.39509553
      A = 0.04046593
      B = 0.02721993
       with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.16899117
lb = 300.00
ld = 1775.241
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 = 18.00
   Mean strength value of all re-bars: fy = 625.00
   fc' = 37.50, 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 = 2.0944
     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 = 150.00
     n = 20.00

- Calculation of θp -

From table 10-8: θp = 0.02523702
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.52496023
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 = 10860.955
Ag = 262500.00
f'cE = 37.50
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.04064862
b = 250.00
d = 507.00
f'cE = 37.50

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

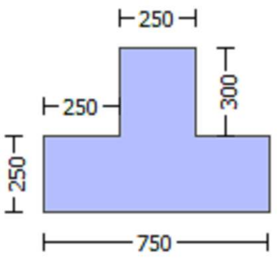
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

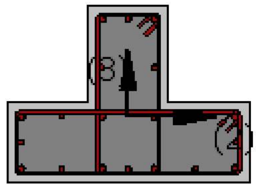
Analysis: Uniform +X

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 Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 28781.504
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 = 37.50
New material: Steel Strength, fs = fsm = 625.00
###
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
Primary 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 = -519569.932
Shear Force, Va = 265.7264
EDGE -B-
Bending Moment, Mb = -277046.274
Shear Force, Vb = -265.7264
BOTH EDGES
Axial Force, F = -10860.955
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten = 2261.947
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2060.885
Mean Diameter of Tension Reinforcement, DbL,ten = 17.77778

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 404687.169
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 404687.169
VCol = 404687.169
knl = 1.00
displacement_ductility_demand = 0.00312492

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 = 519569.932
Vu = 265.7264
d = 0.8*h = 440.00
Nu = 10860.955
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 335103.216
where:
Vs1 = 230383.461 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 500.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.34090909
Vs2 = 104719.755 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 500.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.75
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 = 1.2488062E-005
θy = (My*Ls/3)/EIeff = 0.00399629 ((4.29),Biskinis Phd))
My = 2.9597E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1955.282
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.8270E+013
factor = 0.30
Ag = 262500.00
fc' = 37.50
N = 10860.955
Ec*Ig = 1.6090E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.9027522E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 238.7991
d = 507.00
ξy = 0.39657433
A = 0.04100744
B = 0.02757875
with pt = 0.01784573
pc = 0.00654344
pv = 0.01625945
N = 10860.955
b = 250.00
δ'' = 0.08481262
Φy_comp = 1.1707932E-005
with fc = 37.50
Ec = 28781.504
ξy = 0.39509553
A = 0.04046593
B = 0.02721993
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.16899117
lb = 300.00
ld = 1775.241
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 = 18.00
Mean strength value of all re-bars: fy = 625.00
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

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

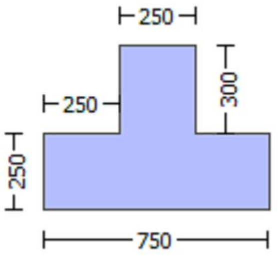
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

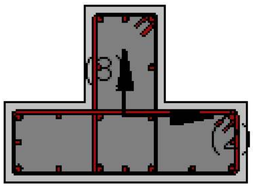
Analysis: Uniform +X

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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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 = 781.25
##
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 = 1.14004
Element Length, L = 3000.00
Primary 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 = 0.00014703
EDGE -B-
Shear Force, Vb = -0.00014703
BOTH EDGES
Axial Force, F = -9867.326
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 2261.947
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2060.885

Calculation of Shear Capacity ratio , Ve/Vr = 0.52496023
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 264455.432
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9668E+008
Mu1+ = 3.9668E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.2114E+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-) = 3.9668E+008
Mu2+ = 3.9668E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.2114E+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 = 7.7193240E-006
Mu = 3.9668E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00207597
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----

psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12241628
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04488597
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11153483

and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1712045
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06277498
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.15598632
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) = 0.32694776
Mu = MRc (4.15) = 3.9668E+008
φu = φsu (4.1) = 7.7193240E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.5970839E-006
Mu = 1.2114E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00069199
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01496199
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04080543
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03717828
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01728586
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04714327
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04295275
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.2124538
Mu = MRc (4.14) = 1.2114E+008
φu = φsu (4.1) = 6.5970839E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.7193240E-006
Mu = 3.9668E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00

v = 0.00207597
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12241628
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04488597
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11153483
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1712045
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06277498
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.15598632
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) = 0.32694776
Mu = MRc (4.15) = 3.9668E+008
φu = φsu (4.1) = 7.7193240E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.5970839E-006
Mu = 1.2114E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00069199
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412

ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01496199
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04080543
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03717828
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01728586
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04714327
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04295275
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.2124538
Mu = MRc (4.14) = 1.2114E+008
φu = φsu (4.1) = 6.5970839E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 503762.797

Calculation of Shear Strength at edge 1, Vr1 = 503762.797
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 503762.797
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
Mu = 788.0877
Vu = 0.00014703
d = 0.8*h = 440.00
Nu = 9867.326
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 418879.02
where:
Vs1 = 287979.327 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.34090909
Vs2 = 130899.694 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.75
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 447481.489
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 503762.797
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 503762.797
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
Mu = 788.0877
Vu = 0.00014703
d = 0.8*h = 440.00
Nu = 9867.326
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 418879.02

where:
Vs1 = 287979.327 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.34090909
Vs2 = 130899.694 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.75
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 447481.489
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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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 = 781.25
##
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 = 1.14004
Element Length, L = 3000.00
Primary 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 = 3.6907929E-008

EDGE -B-
Shear Force, Vb = -3.6907929E-008
BOTH EDGES
Axial Force, F = -9867.326
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2689.203

Calculation of Shear Capacity ratio , Ve/Vr = 0.29501144
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 222553.55
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.3383E+008
Mu1+ = 3.3383E+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- = 3.3383E+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-) = 3.3383E+008
Mu2+ = 3.3383E+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- = 3.3383E+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 = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00

d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412

ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006

Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00

n = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 754389.565

Calculation of Shear Strength at edge 1, Vr1 = 754389.565
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 754389.565
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.45248062
Vu = 3.6907929E-008
d = 0.8*h = 600.00
Nu = 9867.326
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 523598.776
where:
Vs1 = 130899.694 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.75
Vs2 = 392699.082 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 610202.031
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 754389.565
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 754389.565
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.45236986
Vu = 3.6907929E-008
d = 0.8*h = 600.00
Nu = 9867.326
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 523598.776
where:
Vs1 = 130899.694 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00

Vs1 is multiplied by αCol1 = 1.00
s/d = 0.75
Vs2 = 392699.082 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 610202.031
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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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
Primary 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 = -1.3835E+007
Shear Force, V2 = -4487.046
Shear Force, V3 = 265.7264
Axial Force, F = -10860.955
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2689.203
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 = 0.03588176
θu = θy + θp = 0.03588176

 - Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00394268 ((4.29),Biskinis Phd))
   My = 3.0405E+008
   Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3083.371
   From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 7.9262E+013
      factor = 0.30
         Ag = 262500.00
         fc' = 37.50
         N = 10860.955
      Ec*Ig = 2.6421E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.4326278E-006
  with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 238.7991
      d = 707.00
      ξy = 0.30576318
      A = 0.02940704
      B = 0.01571863
       with pt = 0.00696749
           pc = 0.00696749
           pv = 0.01521473
           N = 10860.955
           b = 250.00
           δ'' = 0.06082037
Φy_comp = 1.0916788E-005
 with fc = 37.50
      Ec = 28781.504
      ξy = 0.30386172
      A = 0.02901871
      B = 0.01546131
       with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.16899117
lb = 300.00
ld = 1775.241
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 = 18.00
   Mean strength value of all re-bars: fy = 625.00
   fc' = 37.50, 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 = 2.0944
     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 = 150.00
     n = 20.00

- Calculation of θp -

From table 10-8: θp = 0.03193908
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
  shear control ratio VyE/VCol0E = 0.29501144
  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 = 10860.955
    Ag = 262500.00
    f'cE = 37.50
    fytE = fylE = 0.00

pl = Area_Tot_Long_Rein/(b*d) = 0.02914971
  b = 250.00
  d = 707.00
    f'cE = 37.50

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

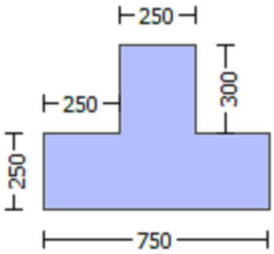
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

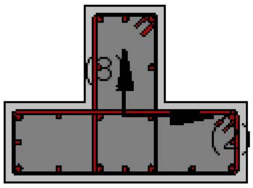
Analysis: Uniform +X

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 Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 28781.504
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 = 37.50
New material: Steel Strength, fs = fsm = 625.00
###
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
Primary 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 = -1.3835E+007
Shear Force, Va = -4487.046
EDGE -B-
Bending Moment, Mb = 370595.336
Shear Force, Vb = 4487.046
BOTH EDGES
Axial Force, F = -10860.955
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2689.203
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 = 607874.181
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 607874.181
VCol = 607874.181
knl = 1.00
displacement_ductility_demand = 0.07167099

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 = 370595.336
Vu = 4487.046
d = 0.8*h = 600.00
Nu = 10860.955
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 418879.02
where:
Vs1 = 104719.755 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 500.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.75
Vs2 = 314159.265 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 500.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.25
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 = 2.7493531E-005
θy = (My*Ls/3)/Eleff = 0.00038361 ((4.29),Biskinis Phd))
My = 3.0405E+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 = 7.9262E+013
factor = 0.30
Ag = 262500.00
fc' = 37.50
N = 10860.955
Ec*Ig = 2.6421E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.4326278E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 238.7991
d = 707.00
ξy = 0.30576318
A = 0.02940704
B = 0.01571863
with pt = 0.00696749
pc = 0.00696749
pv = 0.01521473
N = 10860.955
b = 250.00
δ" = 0.06082037
Φy_comp = 1.0916788E-005
with fc = 37.50
Ec = 28781.504
ξy = 0.30386172
A = 0.02901871
B = 0.01546131
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.16899117
lb = 300.00
ld = 1775.241
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 = 18.00
Mean strength value of all re-bars: fy = 625.00
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

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

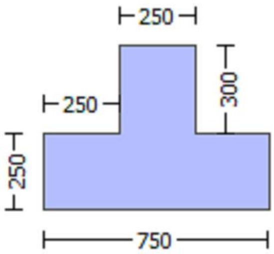
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

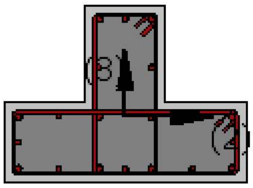
Analysis: Uniform +X

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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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 = 781.25
###
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 = 1.14004
Element Length, L = 3000.00
Primary 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 = 0.00014703
EDGE -B-
Shear Force, Vb = -0.00014703
BOTH EDGES
Axial Force, F = -9867.326
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 2261.947
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2060.885

Calculation of Shear Capacity ratio , Ve/Vr = 0.52496023
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 264455.432
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9668E+008
Mu1+ = 3.9668E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.2114E+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-) = 3.9668E+008
Mu2+ = 3.9668E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.2114E+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 = 7.7193240E-006
Mu = 3.9668E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00207597
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----

psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12241628
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04488597
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11153483

and confined core properties:
  b = 190.00
  d = 477.00
  d' = 13.00
  fcc (5A.2, TBDY) = 42.75139
  εcc (5A.5, TBDY) = 0.00340037
    λc = confinement factor = 1.14004
  ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1712045
  ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06277498
  ωv = Asl,mid/(b*d)*(fsv/fc) = 0.15598632
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) = 0.32694776
Mu = MRc (4.15) = 3.9668E+008
φu = φsu (4.1) = 7.7193240E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
  Mean strength value of all re-bars: fy = 781.25
  fc' = 37.50, 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 = 2.0944
   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 = 150.00
   n = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.5970839E-006
Mu = 1.2114E+008
----
with full section properties:
  b = 750.00
  d = 507.00
  d' = 43.00
  v = 0.00069199
    N = 9867.326
  fc = 37.50
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.00860501
    ωwe (5.4c) = 0.01628822
      ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
        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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01496199
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04080543
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03717828
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01728586
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04714327
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04295275
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.2124538
Mu = MRc (4.14) = 1.2114E+008
φu = φsu (4.1) = 6.5970839E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.7193240E-006
Mu = 3.9668E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00

v = 0.00207597
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12241628
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04488597
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11153483
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1712045
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06277498
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.15598632
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) = 0.32694776
Mu = MRc (4.15) = 3.9668E+008
φu = φsu (4.1) = 7.7193240E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.5970839E-006
Mu = 1.2114E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00069199
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412

ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01496199
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04080543
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03717828
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01728586
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04714327
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04295275
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.2124538
Mu = MRc (4.14) = 1.2114E+008
φu = φsu (4.1) = 6.5970839E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 503762.797

Calculation of Shear Strength at edge 1, Vr1 = 503762.797
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 503762.797
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
Mu = 788.0877
Vu = 0.00014703
d = 0.8*h = 440.00
Nu = 9867.326
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 418879.02
where:
Vs1 = 287979.327 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.34090909
Vs2 = 130899.694 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.75
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 447481.489
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 503762.797
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 503762.797
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
Mu = 788.0877
Vu = 0.00014703
d = 0.8*h = 440.00
Nu = 9867.326
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 418879.02

where:
Vs1 = 287979.327 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.34090909
Vs2 = 130899.694 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.75
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 447481.489
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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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 = 781.25
###
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 = 1.14004
Element Length, L = 3000.00
Primary 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 = 3.6907929E-008

EDGE -B-
Shear Force, Vb = -3.6907929E-008
BOTH EDGES
Axial Force, F = -9867.326
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2689.203

Calculation of Shear Capacity ratio , Ve/Vr = 0.29501144
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 222553.55
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.3383E+008
Mu1+ = 3.3383E+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- = 3.3383E+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-) = 3.3383E+008
Mu2+ = 3.3383E+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- = 3.3383E+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 = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00

d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412

ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006

Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00

n = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 754389.565

Calculation of Shear Strength at edge 1, Vr1 = 754389.565
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 754389.565
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.45248062
Vu = 3.6907929E-008
d = 0.8*h = 600.00
Nu = 9867.326
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 523598.776
where:
Vs1 = 130899.694 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.75
Vs2 = 392699.082 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 610202.031
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 754389.565
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 754389.565
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.45236986
Vu = 3.6907929E-008
d = 0.8*h = 600.00
Nu = 9867.326
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 523598.776
where:
Vs1 = 130899.694 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00

Vs1 is multiplied by αCol1 = 1.00
s/d = 0.75
Vs2 = 392699.082 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 610202.031
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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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
Primary 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 = -277046.274
Shear Force, V2 = 4487.046
Shear Force, V3 = -265.7264
Axial Force, F = -10860.955
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 2261.947
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2060.885
Mean Diameter of Tension Reinforcement, DbL = 17.77778

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.02736793
θu = θy + θp = 0.02736793

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00213091 ((4.29),Biskinis Phd))
My = 2.9597E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1042.60
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.8270E+013
factor = 0.30
Ag = 262500.00
fc' = 37.50
N = 10860.955
Ec*Ig = 1.6090E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.9027522E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 238.7991
d = 507.00
ξy = 0.39657433
A = 0.04100744
B = 0.02757875
with pt = 0.01784573
pc = 0.00654344
pv = 0.01625945
N = 10860.955
b = 250.00
δ'' = 0.08481262
Φy_comp = 1.1707932E-005
with fc = 37.50
Ec = 28781.504
ξy = 0.39509553
A = 0.04046593
B = 0.02721993
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.16899117
lb = 300.00
ld = 1775.241
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 = 18.00
Mean strength value of all re-bars: fy = 625.00
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

- Calculation of θp -

From table 10-8: θp = 0.02523702
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.52496023
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 = 10860.955
Ag = 262500.00
f'cE = 37.50
fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.04064862
b = 250.00
d = 507.00
f'cE = 37.50

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

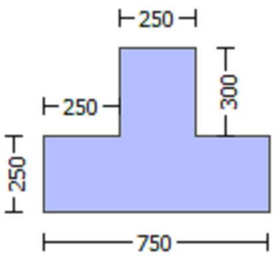
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

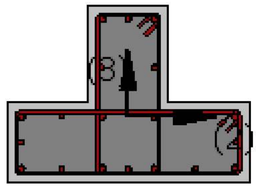
Analysis: Uniform +X

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 Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 28781.504
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 = 37.50
New material: Steel Strength, fs = fsm = 625.00
###
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
Primary 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 = -519569.932
Shear Force, Va = 265.7264
EDGE -B-
Bending Moment, Mb = -277046.274
Shear Force, Vb = -265.7264
BOTH EDGES
Axial Force, F = -10860.955
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten = 2261.947
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2060.885
Mean Diameter of Tension Reinforcement, DbL,ten = 17.77778

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 452567.023
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 452567.023
VCol = 452567.023
knl = 1.00
displacement_ductility_demand = 7.1362984E-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 = 2.36955
Mu = 277046.274
Vu = 265.7264
d = 0.8*h = 440.00
Nu = 10860.955
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 335103.216
where:
Vs1 = 230383.461 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 500.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.34090909
Vs2 = 104719.755 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 500.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.75
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 = 1.5206802E-008
θy = (My*Ls/3)/Eleff = 0.00213091 ((4.29),Biskinis Phd))
My = 2.9597E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1042.60
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 4.8270E+013
factor = 0.30
Ag = 262500.00
fc' = 37.50
N = 10860.955
Ec*Ig = 1.6090E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 3.9027522E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 238.7991
d = 507.00
ξy = 0.39657433
A = 0.04100744
B = 0.02757875
with pt = 0.01784573
pc = 0.00654344
pv = 0.01625945
N = 10860.955
b = 250.00
δ'' = 0.08481262
Φy_comp = 1.1707932E-005
with fc = 37.50
Ec = 28781.504
ξy = 0.39509553
A = 0.04046593
B = 0.02721993
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.16899117
lb = 300.00
ld = 1775.241
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 = 18.00
Mean strength value of all re-bars: fy = 625.00
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

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

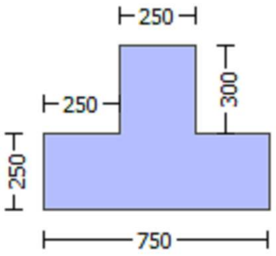
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

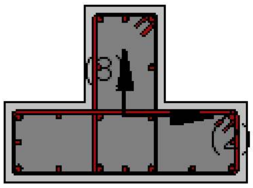
Analysis: Uniform +X

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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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 = 781.25
###
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 = 1.14004
Element Length, L = 3000.00
Primary 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 = 0.00014703
EDGE -B-
Shear Force, Vb = -0.00014703
BOTH EDGES
Axial Force, F = -9867.326
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 2261.947
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 2060.885

Calculation of Shear Capacity ratio , Ve/Vr = 0.52496023
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 264455.432
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.9668E+008
Mu1+ = 3.9668E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.2114E+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-) = 3.9668E+008
Mu2+ = 3.9668E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.2114E+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 = 7.7193240E-006
Mu = 3.9668E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00
v = 0.00207597
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----

psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12241628
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04488597
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11153483

and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1712045
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06277498
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.15598632
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) = 0.32694776
Mu = MRc (4.15) = 3.9668E+008
φu = φsu (4.1) = 7.7193240E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.5970839E-006
Mu = 1.2114E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00069199
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01496199
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04080543
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03717828
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01728586
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04714327
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04295275
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.2124538
Mu = MRc (4.14) = 1.2114E+008
φu = φsu (4.1) = 6.5970839E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.7193240E-006
Mu = 3.9668E+008
----
with full section properties:
b = 250.00
d = 507.00
d' = 43.00

v = 0.00207597
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.12241628
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04488597
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11153483
and confined core properties:
b = 190.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1712045
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06277498
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.15598632
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) = 0.32694776
Mu = MRc (4.15) = 3.9668E+008
φu = φsu (4.1) = 7.7193240E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.5970839E-006
Mu = 1.2114E+008
----
with full section properties:
b = 750.00
d = 507.00
d' = 43.00
v = 0.00069199
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412

ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01496199
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04080543
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03717828
and confined core properties:
b = 690.00
d = 477.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.01728586
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04714327
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04295275
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.2124538
Mu = MRc (4.14) = 1.2114E+008
φu = φsu (4.1) = 6.5970839E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 503762.797

Calculation of Shear Strength at edge 1, Vr1 = 503762.797
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 503762.797
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
Mu = 788.0877
Vu = 0.00014703
d = 0.8*h = 440.00
Nu = 9867.326
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 418879.02
where:
Vs1 = 287979.327 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.34090909
Vs2 = 130899.694 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.75
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 447481.489
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 503762.797
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 503762.797
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
Mu = 788.0877
Vu = 0.00014703
d = 0.8*h = 440.00
Nu = 9867.326
Ag = 137500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 418879.02

where:
Vs1 = 287979.327 is calculated for section web, with:
d = 440.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.34090909
Vs2 = 130899.694 is calculated for section flange, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.75
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 447481.489
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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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 = 781.25
###
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 = 1.14004
Element Length, L = 3000.00
Primary 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 = 3.6907929E-008

EDGE -B-
Shear Force, Vb = -3.6907929E-008
BOTH EDGES
Axial Force, F = -9867.326
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2689.203

Calculation of Shear Capacity ratio , Ve/Vr = 0.29501144
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 222553.55
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.3383E+008
Mu1+ = 3.3383E+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- = 3.3383E+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-) = 3.3383E+008
Mu2+ = 3.3383E+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- = 3.3383E+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 = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00

d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006
Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006
Mu = 3.3383E+008

----

with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412

ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 4.9513544E-006

Mu = 3.3383E+008
----
with full section properties:
b = 250.00
d = 707.00
d' = 43.00
v = 0.00148871
N = 9867.326
fc = 37.50
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00860501
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00860501
ωwe (5.4c) = 0.01628822
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.28820848
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 = 110400.00 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) = 0.00271274
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00271274
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) = 0.00351061
Lstir (Length of stirrups along X) = 1760.00
Astir (stirrups area) = 78.53982
Asec (section area) = 262500.00
----
s = 150.00
fywe = 781.25
fce = 37.50
From ((5.A5), TBDY), TBDY: εcc = 0.00340037
λc = confinement factor = 1.14004
εy1 = 0.00082316
εsh1 = 0.00263412
ft1 = 308.6863
fy1 = 257.2385
εsu1 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Es1 = Es = 200000.00
εy2 = 0.00082316
εsh2 = 0.00263412
ft2 = 308.6863
fy2 = 257.2385
εsu2 = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.13519294
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 = 257.2385
with Es2 = Es = 200000.00
εyv = 0.00082316
εshv = 0.00263412
ftv = 308.6863
fyv = 257.2385
εsuv = 0.00263412
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.13519294
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 = 257.2385
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04779487
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04779487
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10436839
and confined core properties:
b = 190.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 42.75139
εcc (5A.5, TBDY) = 0.00340037
λc = confinement factor = 1.14004
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06567475
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06567475
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.14341222
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.24752413
Mu = MRc (4.14) = 3.3383E+008
φu = φsu (4.1) = 4.9513544E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.13519294
lb = 300.00
ld = 2219.051
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 = 18.00
Mean strength value of all re-bars: fy = 781.25
fc' = 37.50, 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 = 2.0944
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 = 150.00

n = 20.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 754389.565

Calculation of Shear Strength at edge 1, Vr1 = 754389.565
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 754389.565
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.45248062
Vu = 3.6907929E-008
d = 0.8*h = 600.00
Nu = 9867.326
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 523598.776
where:
Vs1 = 130899.694 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.75
Vs2 = 392699.082 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 610202.031
bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 754389.565
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 754389.565
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' = 37.50, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.45236986
Vu = 3.6907929E-008
d = 0.8*h = 600.00
Nu = 9867.326
Ag = 187500.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 523598.776
where:
Vs1 = 130899.694 is calculated for section web, with:
d = 200.00
Av = 157079.633
fy = 625.00
s = 150.00

Vs1 is multiplied by αCol1 = 1.00
s/d = 0.75
Vs2 = 392699.082 is calculated for section flange, with:
d = 600.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.25
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 610202.031
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 Primary Member: Concrete Strength, fc = fcm = 37.50
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 28781.504
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
Primary 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 = 370595.336
Shear Force, V2 = 4487.046
Shear Force, V3 = -265.7264
Axial Force, F = -10860.955
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 5152.212
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1231.504
-Compression: Asl,com = 1231.504
-Middle: Asl,mid = 2689.203
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 = 0.03232269
θu = θy + θp = 0.03232269

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00038361 ((4.29),Biskinis Phd))
My = 3.0405E+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 = 7.9262E+013
factor = 0.30
Ag = 262500.00
fc' = 37.50
N = 10860.955
Ec*Ig = 2.6421E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.4326278E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 238.7991
d = 707.00
ξy = 0.30576318
A = 0.02940704
B = 0.01571863
with pt = 0.00696749
pc = 0.00696749
pv = 0.01521473
N = 10860.955
b = 250.00
δ'' = 0.06082037
Φy_comp = 1.0916788E-005
with fc = 37.50
Ec = 28781.504
ξy = 0.30386172
A = 0.02901871
B = 0.01546131
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.16899117
lb = 300.00
ld = 1775.241
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 = 18.00
Mean strength value of all re-bars: fy = 625.00
fc' = 37.50, 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 = 2.0944
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 = 150.00
n = 20.00

- Calculation of θp -

From table 10-8: θp = 0.03193908
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
  shear control ratio VyE/VCol0E = 0.29501144
  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 = 10860.955
    Ag = 262500.00
    f'cE = 37.50
    fytE = fylE = 0.00

pl = Area_Tot_Long_Rein/(b*d) = 0.02914971
  b = 250.00
  d = 707.00
    f'cE = 37.50

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