Detailed Member Calculations

Units: N&mm

Regulation: ASCE 41-17

Calculation No. 1

column C1, Floor 1

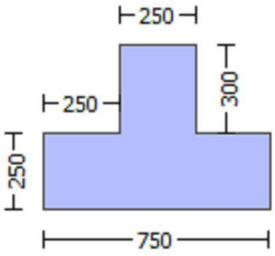
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

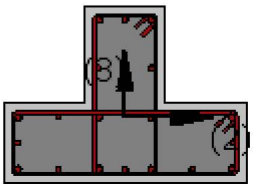
Analysis: Uniform +X

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
Adequate Lap Length (lo/lou,min = lb/ld >=1)
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 = 0.00738073

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 = 0.01026021 ((4.29),Biskinis Phd))
My = 7.9125E+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 = 6.3530147E-006
with fy = 625.00
d = 707.00
ξy = 0.30425395
A = 0.02924803
B = 0.01555962
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

Adequate Lap Length: lb/ld >= 1

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

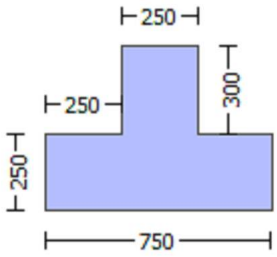
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

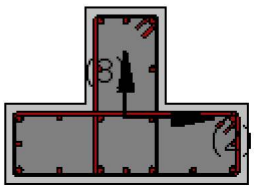
Analysis: Uniform +X

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
Adequate Lap Length (lo/lou,min>=1)
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 = 1.35949
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 684862.956
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.0273E+009
Mu1+ = 1.0273E+009, 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- = 7.8532E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.0273E+009
Mu2+ = 1.0273E+009, 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- = 7.8532E+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 = 1.5224730E-005
Mu = 1.0273E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.37178611
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.13632157
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.33873846
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) = 0.51995906
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19065166
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.47374048
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.38433228
MRc (4.17) = 9.9628E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is satisfied
--->
ξ*cu (4.10) = 0.46822902
MRo (4.17) = 1.0273E+009
--->
φu = φcu (4.2) = 1.5224730E-005

Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.1537995E-005
Mu = 7.8532E+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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00

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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04544052
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1239287
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11291282
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) = 0.05249828
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.14317713
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.13045028
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.1177224
Mu = MRc (4.14) = 7.8532E+008
φu = φsu (4.1) = 7.1537995E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.5224730E-005
Mu = 1.0273E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00

εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.37178611
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.13632157
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.33873846
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) = 0.51995906
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19065166
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.47374048
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.38433228
MRc (4.17) = 9.9628E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made

- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is satisfied
--->
ξ*cu (4.10) = 0.46822902
MRo (4.17) = 1.0273E+009
--->
φu = φcu (4.2) = 1.5224730E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.1537995E-005
Mu = 7.8532E+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) = 1760.00

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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04544052
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1239287
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11291282
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) = 0.05249828
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.14317713
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.13045028
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.1177224
Mu = MRc (4.14) = 7.8532E+008
φu = φsu (4.1) = 7.1537995E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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
Adequate Lap Length (lo/lou,min>=1)
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 = 1.36361
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 1.0287E+006
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5430E+009
Mu1+ = 1.5430E+009, 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- = 1.5430E+009, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.5430E+009
Mu2+ = 1.5430E+009, 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- = 1.5430E+009, 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 = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561

ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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
Adequate Lap Length (lb/ld>=1)
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 = 0.01163902
θu = θy + θp = 0.01163902

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.01041792 ((4.29),Biskinis Phd))
My = 7.7156E+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 = 1.0191412E-005
with fy = 625.00
d = 507.00
ξy = 0.39520568
A = 0.04078572
B = 0.02735703
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

Adequate Lap Length: lb/ld >= 1

 - Calculation of θp -

From table 10-8: θp = 0.0012211
with:
 - Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
   shear control ratio VyE/VCol0E = 1.35949
   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. 3

column C1, Floor 1

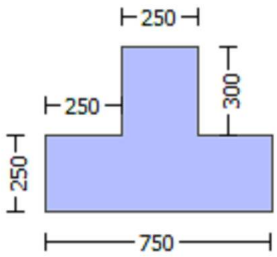
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

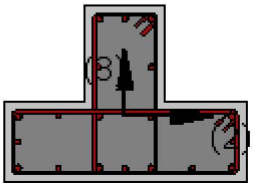
Analysis: Uniform +X

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
Adequate Lap Length (lo/lou,min = lb/ld >=1)
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 = 0.00119871

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 = 0.01041792 ((4.29),Biskinis Phd))
My = 7.7156E+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 = 1.0191412E-005
with fy = 625.00
d = 507.00
ξy = 0.39520568
A = 0.04078572
B = 0.02735703
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

Adequate Lap Length: lb/ld >= 1

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

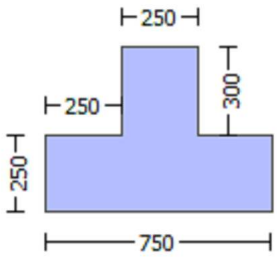
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

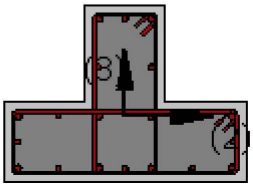
Analysis: Uniform +X

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
Adequate Lap Length (lo/lou,min>=1)
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 = 1.35949
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 684862.956
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.0273E+009
Mu1+ = 1.0273E+009, 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- = 7.8532E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.0273E+009
Mu2+ = 1.0273E+009, 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- = 7.8532E+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 = 1.5224730E-005
Mu = 1.0273E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.37178611
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.13632157
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.33873846
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) = 0.51995906
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19065166
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.47374048
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.38433228
MRc (4.17) = 9.9628E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
  - σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is satisfied
--->
ξ*cu (4.10) = 0.46822902
MRo (4.17) = 1.0273E+009
--->
φu = φcu (4.2) = 1.5224730E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.1537995E-005
Mu = 7.8532E+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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25

εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04544052
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1239287
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11291282
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) = 0.05249828
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.14317713
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.13045028
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.1177224
Mu = MRc (4.14) = 7.8532E+008
φu = φsu (4.1) = 7.1537995E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.5224730E-005
Mu = 1.0273E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.37178611
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.13632157
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.33873846
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) = 0.51995906
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19065166
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.47374048
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.38433228
MRc (4.17) = 9.9628E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is satisfied
--->
ξ*cu (4.10) = 0.46822902
MRo (4.17) = 1.0273E+009
--->
φu = φcu (4.2) = 1.5224730E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.1537995E-005
Mu = 7.8532E+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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04544052
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1239287
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11291282
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) = 0.05249828
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.14317713
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.13045028
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.1177224
Mu = MRc (4.14) = 7.8532E+008
φu = φsu (4.1) = 7.1537995E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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
Adequate Lap Length (lo/lou,min>=1)
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 = 1.36361
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 1.0287E+006
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5430E+009
Mu1+ = 1.5430E+009, 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- = 1.5430E+009, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.5430E+009
Mu2+ = 1.5430E+009, 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- = 1.5430E+009, 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 = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25

with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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
Adequate Lap Length (lb/ld>=1)
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 = 0.01154252
θu = θy + θp = 0.01154252

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.01026021 ((4.29),Biskinis Phd))
My = 7.9125E+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 = 6.3530147E-006
with fy = 625.00
d = 707.00
ξy = 0.30425395
A = 0.02924803
B = 0.01555962
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

Adequate Lap Length: lb/ld >= 1

- Calculation of θp -

From table 10-8: θp = 0.00128231
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
shear control ratio VyE/VColOE = 1.36361
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. 5

column C1, Floor 1

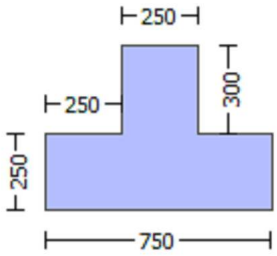
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

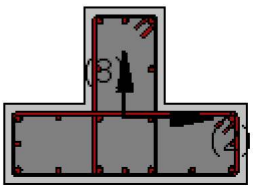
Analysis: Uniform +X

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
Adequate Lap Length (lo/lou,min = lb/ld >=1)
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 = 0.02754095
------------------------------------------------------------
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)/EIeff = 0.00099828 ((4.29),Biskinis Phd))
My = 7.9125E+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 = 6.3530147E-006
with fy = 625.00
d = 707.00
ξy = 0.30425395
A = 0.02924803
B = 0.01555962
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

Adequate Lap Length: lb/ld >= 1

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

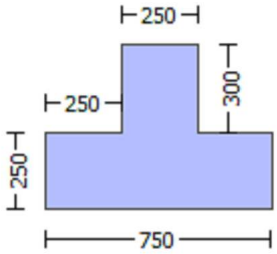
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

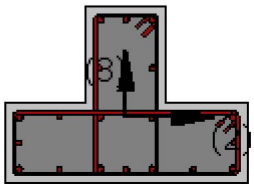
Analysis: Uniform +X

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

Adequate Lap Length (lo/lou,min>=1)
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 = 1.35949
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 684862.956
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.0273E+009
Mu1+ = 1.0273E+009, 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- = 7.8532E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.0273E+009
Mu2+ = 1.0273E+009, 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- = 7.8532E+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 = 1.5224730E-005
Mu = 1.0273E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
        with Esv = Es = 200000.00
   ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.37178611
   ω2 = Asl,com/(b*d)*(fs2/fc) = 0.13632157
   ωv = Asl,mid/(b*d)*(fsv/fc) = 0.33873846
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) = 0.51995906
   ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19065166
   ωv = Asl,mid/(b*d)*(fsv/fc) = 0.47374048
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6)  is satisfied
--->
ξcu (4.10) = 0.38433228
MRc (4.17) = 9.9628E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
   - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
   - N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
   - σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is satisfied
--->
ξ*cu (4.10) = 0.46822902
MRo (4.17) = 1.0273E+009
--->
φu = φcu (4.2) = 1.5224730E-005
Mu = MRo
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
------------------------------------------------------------------------
```


Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.1537995E-005
Mu = 7.8532E+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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00

εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04544052
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1239287
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11291282
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) = 0.05249828
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.14317713
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.13045028
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.1177224
Mu = MRc (4.14) = 7.8532E+008
φu = φsu (4.1) = 7.1537995E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

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

φu = 1.5224730E-005
Mu = 1.0273E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.37178611
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.13632157
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.33873846
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) = 0.51995906
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19065166
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.47374048
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.38433228
MRc (4.17) = 9.9628E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied

--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is satisfied
--->
ξ*cu (4.10) = 0.46822902
MRo (4.17) = 1.0273E+009
--->
φu = φcu (4.2) = 1.5224730E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.1537995E-005
Mu = 7.8532E+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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04544052
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1239287
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11291282
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) = 0.05249828
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.14317713

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.13045028
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.1177224
Mu = MRc (4.14) = 7.8532E+008
φu = φsu (4.1) = 7.1537995E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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
Adequate Lap Length (lo/lou,min>=1)
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 = 1.36361
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 1.0287E+006
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5430E+009
Mu1+ = 1.5430E+009, 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- = 1.5430E+009, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.5430E+009
Mu2+ = 1.5430E+009, 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- = 1.5430E+009, 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 = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352

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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212

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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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
Adequate Lap Length (lb/ld>=1)
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 = 0.00677617
θu = θy + θp = 0.00677617

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00555507 ((4.29),Biskinis Phd))
My = 7.7156E+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 = 1.0191412E-005
with fy = 625.00
d = 507.00
ξy = 0.39520568
A = 0.04078572
B = 0.02735703
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

Adequate Lap Length: lb/ld >= 1

- Calculation of θp -

From table 10-8: θp = 0.0012211
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
shear control ratio VyE/VCol0E = 1.35949
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. 7

column C1, Floor 1

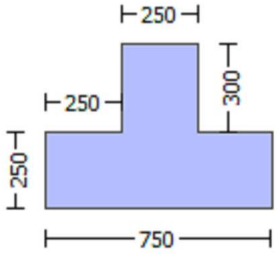
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

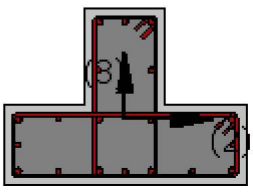
Analysis: Uniform +X

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
Adequate Lap Length (lo/lou,min = lb/ld >=1)
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 = 2.7374639E-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)/EIeff = 0.00555507 ((4.29),Biskinis Phd))
My = 7.7156E+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 = 1.0191412E-005
with fy = 625.00
d = 507.00
ξy = 0.39520568
A = 0.04078572
B = 0.02735703
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

Adequate Lap Length: lb/ld >= 1

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

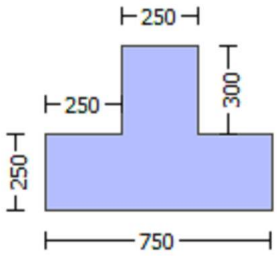
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

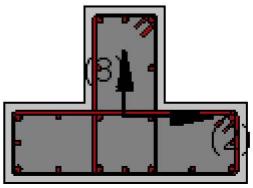
Analysis: Uniform +X

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
Adequate Lap Length (lo/lou,min>=1)
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 = 1.35949
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 684862.956
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.0273E+009
Mu1+ = 1.0273E+009, 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- = 7.8532E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.0273E+009
Mu2+ = 1.0273E+009, 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- = 7.8532E+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 = 1.5224730E-005
Mu = 1.0273E+009

---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00

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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.37178611
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.13632157
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.33873846
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) = 0.51995906
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19065166
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.47374048
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.38433228
MRc (4.17) = 9.9628E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied

--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is satisfied
--->
ξ*cu (4.10) = 0.46822902
MRo (4.17) = 1.0273E+009
--->
φu = φcu (4.2) = 1.5224730E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.1537995E-005
Mu = 7.8532E+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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04544052
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1239287
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11291282
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) = 0.05249828
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.14317713
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.13045028
Case/Assumption: Unconfinesd full section - Steel rupture

δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.1177224
Mu = MRc (4.14) = 7.8532E+008
φu = φsu (4.1) = 7.1537995E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.5224730E-005
Mu = 1.0273E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50

fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.37178611
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.13632157
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.33873846
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) = 0.51995906
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19065166
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.47374048
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 not satisfied
--->
Case/Assumption Rejected.

--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.38433228
MRc (4.17) = 9.9628E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
  - σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is satisfied
--->
ξ*cu (4.10) = 0.46822902
MRo (4.17) = 1.0273E+009
--->
φu = φcu (4.2) = 1.5224730E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.1537995E-005
Mu = 7.8532E+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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00

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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04544052
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1239287
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11291282
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) = 0.05249828
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.14317713
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.13045028
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.1177224
Mu = MRc (4.14) = 7.8532E+008
φu = φsu (4.1) = 7.1537995E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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
Adequate Lap Length (lo/lou,min>=1)
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 = 1.36361
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 1.0287E+006
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5430E+009
Mu1+ = 1.5430E+009, 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- = 1.5430E+009, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.5430E+009
Mu2+ = 1.5430E+009, 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- = 1.5430E+009, 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 = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00

εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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
Adequate Lap Length (lb/ld>=1)
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 = 0.00228059
θu = θy + θp = 0.00228059

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00099828 ((4.29),Biskinis Phd))
My = 7.9125E+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 = 6.3530147E-006
with fy = 625.00
d = 707.00
ξy = 0.30425395
A = 0.02924803
B = 0.01555962
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

Adequate Lap Length: lb/ld >= 1

- Calculation of θp -

From table 10-8: θp = 0.00128231
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
shear control ratio VyE/VColOE = 1.36361
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)

Calculation No. 9

column C1, Floor 1

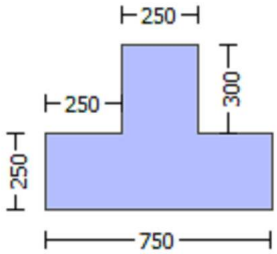
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

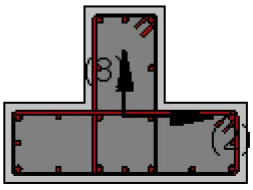
Analysis: Uniform +X

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
Adequate Lap Length (lo/lou,min = lb/ld >=1)
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 = 0.00469494

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)/Eleff = 0.01025899 ((4.29),Biskinis Phd))

My = 7.9116E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3083.371
From table 10.5, ASCE 41_17: Eleff = 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 = 6.3527299E-006
with fy = 625.00
d = 707.00
ξy = 0.30422276
A = 0.02924476
B = 0.01555635
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

Adequate Lap Length: lb/ld >= 1

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

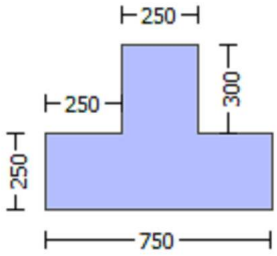
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

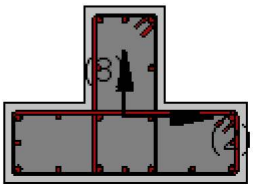
Analysis: Uniform +X

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
Adequate Lap Length (lo/lou,min>=1)
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 = 1.35949
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 684862.956
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.0273E+009
Mu1+ = 1.0273E+009, 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- = 7.8532E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.0273E+009
Mu2+ = 1.0273E+009, 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- = 7.8532E+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 = 1.5224730E-005
Mu = 1.0273E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.37178611
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.13632157
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.33873846

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) = 0.51995906
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19065166
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.47374048
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.38433228
MRc (4.17) = 9.9628E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is satisfied
--->
ξ*cu (4.10) = 0.46822902
MRo (4.17) = 1.0273E+009
--->
φu = φcu (4.2) = 1.5224730E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

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

φu = 7.1537995E-005
Mu = 7.8532E+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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04544052
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1239287
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11291282
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) = 0.05249828
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.14317713
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.13045028
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.1177224
Mu = MRc (4.14) = 7.8532E+008
φu = φsu (4.1) = 7.1537995E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.5224730E-005
Mu = 1.0273E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.37178611
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.13632157
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.33873846
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) = 0.51995906
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19065166
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.47374048
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.38433228
MRc (4.17) = 9.9628E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->

v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is satisfied
--->
ξ*cu (4.10) = 0.46822902
MRo (4.17) = 1.0273E+009
--->
φu = φcu (4.2) = 1.5224730E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.1537995E-005
Mu = 7.8532E+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) = 1760.00
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) = 1360.00
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 = 0.0025

εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04544052
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1239287
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11291282
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) = 0.05249828
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.14317713
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.13045028
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.1177224

Mu = MRc (4.14) = 7.8532E+008
φu = φsu (4.1) = 7.1537995E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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
Adequate Lap Length (lo/lou,min>=1)
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 = 1.36361
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 1.0287E+006
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5430E+009
Mu1+ = 1.5430E+009, 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- = 1.5430E+009, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.5430E+009
Mu2+ = 1.5430E+009, 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- = 1.5430E+009, 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 = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00

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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00

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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008

ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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
Adequate Lap Length (lb/ld>=1)
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 = 0.04848363
θu = θy + θp = 0.04848363

- Calculation of θy -

θy = (My*Ls/3)/Eleff = 0.01040803 ((4.29),Biskinis Phd))
My = 7.7150E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1953.584
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 = 1.0190935E-005
with fy = 625.00
d = 507.00
ξy = 0.3951774
A = 0.04078115
B = 0.02735246
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

Adequate Lap Length: lb/ld >= 1

- Calculation of θp -

From table 10-8: θp = 0.03807561
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
shear control ratio VyE/VCol0E = 1.35949
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. 11

column C1, Floor 1

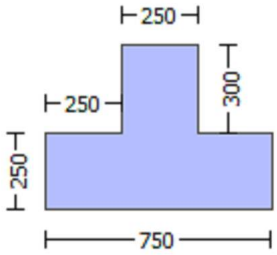
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

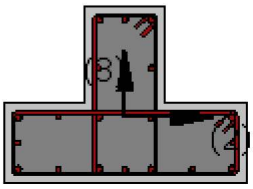
Analysis: Uniform +X

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
Adequate Lap Length (lo/lou,min = lb/ld >=1)
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 = 0.00076366

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 = 0.01040803 ((4.29),Biskinis Phd))
My = 7.7150E+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 = 1.0190935E-005
with fy = 625.00
d = 507.00
ξy = 0.3951774
A = 0.04078115
B = 0.02735246
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

Adequate Lap Length: lb/ld >= 1

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

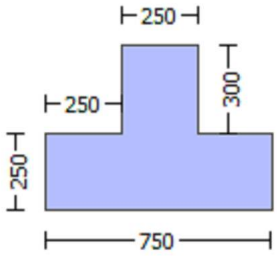
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

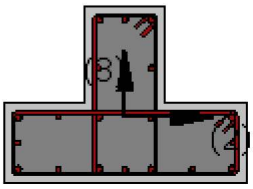
Analysis: Uniform +X

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
Adequate Lap Length (lo/lou,min>=1)
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 = 1.35949
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 684862.956
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.0273E+009
Mu1+ = 1.0273E+009, 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- = 7.8532E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.0273E+009
Mu2+ = 1.0273E+009, 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- = 7.8532E+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 = 1.5224730E-005
Mu = 1.0273E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00

εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.37178611
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.13632157
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.33873846
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) = 0.51995906
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19065166
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.47374048
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.38433228
MRc (4.17) = 9.9628E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->

v* < v*c,y1 - RHS eq.(4.6) is satisfied
--->
ξ*cu (4.10) = 0.46822902
MRo (4.17) = 1.0273E+009
--->
φu = φcu (4.2) = 1.5224730E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.1537995E-005
Mu = 7.8532E+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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50

fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04544052
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1239287
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11291282
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) = 0.05249828
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.14317713
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.13045028
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.1177224
Mu = MRc (4.14) = 7.8532E+008
φu = φsu (4.1) = 7.1537995E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.5224730E-005
Mu = 1.0273E+009
---
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) = 1760.00
        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) = 1360.00
        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 = 0.0025
  εsh1 = 0.008
  ft1 = 937.50
  fy1 = 781.25
  εsu1 = 0.032
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 1.00
    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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.37178611
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.13632157
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.33873846
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) = 0.51995906
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19065166
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.47374048
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied

--->
ξcu (4.10) = 0.38433228
MRc (4.17) = 9.9628E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is satisfied
--->
ξ*cu (4.10) = 0.46822902
MRo (4.17) = 1.0273E+009
--->
φu = φcu (4.2) = 1.5224730E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.1537995E-005
Mu = 7.8532E+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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25

with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04544052
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1239287
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11291282
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) = 0.05249828
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.14317713
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.13045028
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.1177224
Mu = MRc (4.14) = 7.8532E+008
φu = φsu (4.1) = 7.1537995E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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
Adequate Lap Length (lo/lou,min>=1)
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 = 1.36361
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 1.0287E+006
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5430E+009
Mu1+ = 1.5430E+009, 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- = 1.5430E+009, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.5430E+009
Mu2+ = 1.5430E+009, 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- = 1.5430E+009, 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 = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008

ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00

ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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
Adequate Lap Length (lb/ld>=1)
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 = 0.05230344
θu = θy + θp = 0.05230344

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.01025899 ((4.29),Biskinis Phd))
My = 7.9116E+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 = 6.3527299E-006
with fy = 625.00
d = 707.00
ξy = 0.30422276
A = 0.02924476
B = 0.01555635
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

Adequate Lap Length: lb/ld >= 1

- Calculation of θp -

From table 10-8: θp = 0.04204445
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
shear control ratio VyE/VColOE = 1.36361
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. 13

column C1, Floor 1

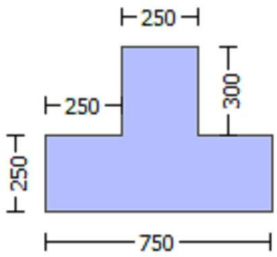
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

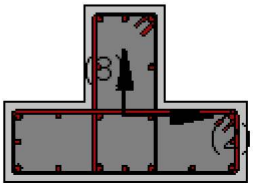
Analysis: Uniform +X

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
Adequate Lap Length (lo/lou,min = lb/ld >=1)
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 = 0.01751901

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 = 0.00099816 ((4.29),Biskinis Phd))
My = 7.9116E+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 = 6.3527299E-006
with fy = 625.00
d = 707.00
ξy = 0.30422276
A = 0.02924476
B = 0.01555635
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

Adequate Lap Length: lb/ld >= 1

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

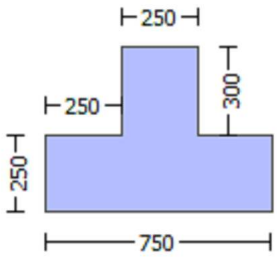
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

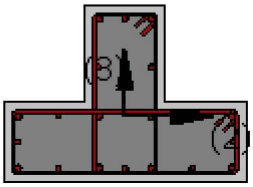
Analysis: Uniform +X

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
Adequate Lap Length (lo/lou,min>=1)
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 = 1.35949
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 684862.956
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.0273E+009
Mu1+ = 1.0273E+009, 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- = 7.8532E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.0273E+009
Mu2+ = 1.0273E+009, 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- = 7.8532E+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 = 1.5224730E-005
Mu = 1.0273E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.37178611
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.13632157
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.33873846
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) = 0.51995906
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19065166
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.47374048
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.38433228
MRc (4.17) = 9.9628E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
  - σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is satisfied
--->
ξ*cu (4.10) = 0.46822902
MRo (4.17) = 1.0273E+009
--->
φu = φcu (4.2) = 1.5224730E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.1537995E-005
Mu = 7.8532E+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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25

εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04544052
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1239287
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11291282
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) = 0.05249828
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.14317713
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.13045028
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.1177224
Mu = MRc (4.14) = 7.8532E+008
φu = φsu (4.1) = 7.1537995E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.5224730E-005
Mu = 1.0273E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.37178611
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.13632157
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.33873846
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) = 0.51995906
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19065166
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.47374048
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.38433228
MRc (4.17) = 9.9628E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is satisfied
--->
ξ*cu (4.10) = 0.46822902
MRo (4.17) = 1.0273E+009
--->
φu = φcu (4.2) = 1.5224730E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.1537995E-005
Mu = 7.8532E+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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04544052
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1239287
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11291282
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) = 0.05249828
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.14317713
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.13045028
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.1177224
Mu = MRc (4.14) = 7.8532E+008
φu = φsu (4.1) = 7.1537995E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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
Adequate Lap Length (lo/lou,min>=1)
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 = 1.36361
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 1.0287E+006
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5430E+009
Mu1+ = 1.5430E+009, 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- = 1.5430E+009, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.5430E+009
Mu2+ = 1.5430E+009, 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- = 1.5430E+009, 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 = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25

with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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
Adequate Lap Length (lb/ld>=1)
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 = 0.04363926
θu = θy + θp = 0.04363926

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00556365 ((4.29),Biskinis Phd))
My = 7.7150E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1044.297
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 = 1.0190935E-005
with fy = 625.00
d = 507.00
ξy = 0.3951774
A = 0.04078115
B = 0.02735246
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

Adequate Lap Length: lb/ld >= 1

- Calculation of θp -

From table 10-8: θp = 0.03807561
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
shear control ratio VyE/VColOE = 1.35949
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. 15

column C1, Floor 1

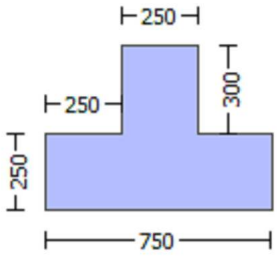
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

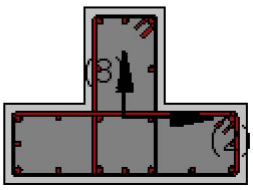
Analysis: Uniform +X

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
Adequate Lap Length (lo/lou,min = lb/ld >=1)
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 = 2.7132450E-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)/EIeff = 0.00556365 ((4.29),Biskinis Phd))
My = 7.7150E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1044.297
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 = 1.0190935E-005
with fy = 625.00
d = 507.00
ξy = 0.3951774
A = 0.04078115
B = 0.02735246
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

Adequate Lap Length: lb/ld >= 1

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

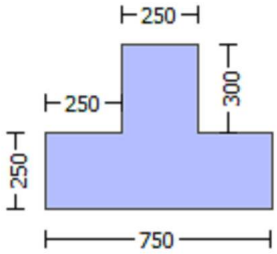
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

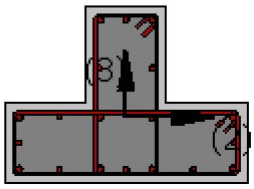
Analysis: Uniform +X

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

Adequate Lap Length (lo/lou,min>=1)
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 = 1.35949
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 684862.956
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.0273E+009
Mu1+ = 1.0273E+009, 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- = 7.8532E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.0273E+009
Mu2+ = 1.0273E+009, 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- = 7.8532E+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 = 1.5224730E-005
Mu = 1.0273E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.37178611
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.13632157
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.33873846
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) = 0.51995906
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19065166
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.47374048
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.38433228
MRc (4.17) = 9.9628E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is satisfied
--->
ξ*cu (4.10) = 0.46822902
MRo (4.17) = 1.0273E+009
--->
φu = φcu (4.2) = 1.5224730E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.1537995E-005
Mu = 7.8532E+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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00

εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04544052
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1239287
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11291282
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) = 0.05249828
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.14317713
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.13045028
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.1177224
Mu = MRc (4.14) = 7.8532E+008
φu = φsu (4.1) = 7.1537995E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

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

φu = 1.5224730E-005
Mu = 1.0273E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.37178611
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.13632157
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.33873846
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) = 0.51995906
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19065166
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.47374048
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.38433228
MRc (4.17) = 9.9628E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied

--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is satisfied
--->
ξ*cu (4.10) = 0.46822902
MRo (4.17) = 1.0273E+009
--->
φu = φcu (4.2) = 1.5224730E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.1537995E-005
Mu = 7.8532E+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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04544052
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1239287
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.11291282
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) = 0.05249828
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.14317713

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.13045028
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.1177224
Mu = MRc (4.14) = 7.8532E+008
φu = φsu (4.1) = 7.1537995E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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
Adequate Lap Length (lo/lou,min>=1)
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 = 1.36361
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 1.0287E+006
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5430E+009
Mu1+ = 1.5430E+009, 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- = 1.5430E+009, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.5430E+009
Mu2+ = 1.5430E+009, 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- = 1.5430E+009, 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 = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352

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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212
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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 6.9461383E-005
Mu = 1.5430E+009
---
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) = 1760.00
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) = 1360.00
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 = 0.0025
εsh1 = 0.008
ft1 = 937.50
fy1 = 781.25
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Es1 = Es = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 937.50
fy2 = 781.25
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
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 = 781.25
with Es2 = Es = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 937.50
fyv = 781.25
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
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 = 781.25
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.1451561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.1451561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.31697352
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) = 0.19945845
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.19945845
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.43555212

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) = 0.34839091
Mu = MRc (4.15) = 1.5430E+009
φu = φsu (4.1) = 6.9461383E-005

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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
Adequate Lap Length (lb/ld>=1)
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 = 0.04304261
θu = θy + θp = 0.04304261

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00099816 ((4.29),Biskinis Phd))
My = 7.9116E+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 = 6.3527299E-006
with fy = 625.00
d = 707.00
ξy = 0.30422276
A = 0.02924476
B = 0.01555635
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

Adequate Lap Length: lb/ld >= 1

- Calculation of θp -

From table 10-8: θp = 0.04204445
with:
 - Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
   shear control ratio VyE/VCol0E = 1.36361
   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)