Detailed Member Calculations

Units: N&mm

Regulation: ASCE 41-17

Calculation No. 1

column C1, Floor 1

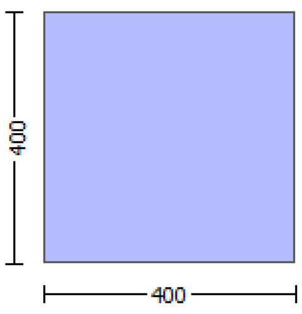
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

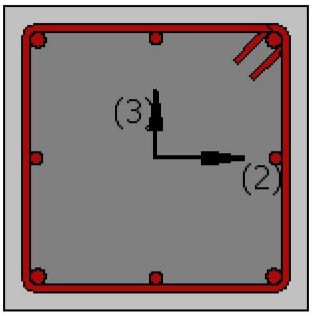
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)





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

Constant Properties

Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039

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, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.4444
##
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed 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 = -1.3509E+007
Shear Force, Va = -4501.47
EDGE -B-
Bending Moment, Mb = 0.06798356
Shear Force, Vb = 4501.47
BOTH EDGES
Axial Force, F = -5925.13
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 829.3805
-Compression: Aslc = 1231.504
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 18.66667

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = κ*Vn = 265424.883
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 265424.883
VCol = 265424.883
knl = 1.00
displacement_ductility_demand = 0.02779005

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

λ = 1 (normal-weight concrete)
fc' = 16.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
Mu = 1.3509E+007
Vu = 4501.47
d = 0.8*h = 320.00
Nu = 5925.13
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 201061.93
Av = 157079.633
fy = 400.00
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: Vs + Vf <= 340123.561
bw = 400.00

----

displacement_ductility_demand is calculated as θ/θy

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

From analysis, chord rotation θ = 0.00028277
θy = (My*Ls/3)/EIeff = 0.01017529 ((4.29),Biskinis Phd))
My = 1.3683E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3001.112
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3452E+013
factor = 0.30
Ag = 160000.00
fc' = 20.00
N = 5925.13
Ec*Ig = 4.4841E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 8.6431581E-006
with fy = 444.4444
d = 357.00
ξy = 0.27981045
A = 0.01452532
B = 0.00817849
with pt = 0.00580799
pc = 0.00580799
pv = 0.00281599
N = 5925.13
b = 400.00
δ'' = 0.12044818
Φy_comp = 1.7192695E-005
with fc = 20.00
Ec = 21019.039
ξy = 0.27904708
A = 0.01431084
B = 0.00808514
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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

Calculation No. 2

column C1, Floor 1

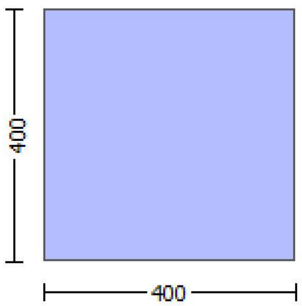
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

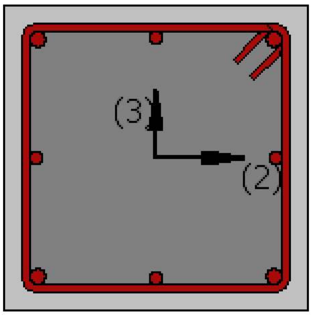
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (2)





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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
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
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
###
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.16547
Element Length, L = 3000.00
Primary Member
Ribbed 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 = 1.4743485E-030
EDGE -B-
Shear Force, Vb = -1.4743485E-030
BOTH EDGES
Axial Force, F = -5926.932
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.38885512
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 142781.295
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.1417E+008
Mu1+ = 2.1417E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.1417E+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-) = 2.1417E+008
Mu2+ = 2.1417E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.1417E+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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00

----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00

fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556

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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667

fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----

with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008

ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 367183.782

Calculation of Shear Strength at edge 1, Vr1 = 367183.782
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.7295387E-012
Vu = 1.4743485E-030
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00

Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 367183.782
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.7295387E-012
Vu = 1.4743485E-030
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
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
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
###
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.16547
Element Length, L = 3000.00
Primary Member
Ribbed 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 = -9.0274828E-047
EDGE -B-
Shear Force, Vb = 9.0274828E-047
BOTH EDGES
Axial Force, F = -5926.932
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.38885512
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 142781.295
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.1417E+008
Mu1+ = 2.1417E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.1417E+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-) = 2.1417E+008
Mu2+ = 2.1417E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.1417E+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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699

----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469

λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied

--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.

with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 367183.782

Calculation of Shear Strength at edge 1, Vr1 = 367183.782
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 2.3349580E-013
Vu = 9.0274828E-047
d = 0.8*h = 320.00
Nu = 5926.932

Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 367183.782
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 2.3349580E-013
Vu = 9.0274828E-047
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed 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 = 2.3177645E-010
Shear Force, V2 = -4501.47
Shear Force, V3 = 3.5573278E-014
Axial Force, F = -5925.13
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 829.3805
-Compression: Aslc = 1231.504
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL = 18.66667

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = κ*θu = 0.00977031
θu = θy + θp = 0.00977031

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00508576 ((4.29),Biskinis Phd))
My = 1.3683E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3452E+013
factor = 0.30
Ag = 160000.00
fc' = 20.00
N = 5925.13
Ec*Ig = 4.4841E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 8.6431581E-006
with fy = 444.4444
d = 357.00
ξy = 0.27981045
A = 0.01452532
B = 0.00817849
with pt = 0.00392699
pc = 0.00580799
pv = 0.00281599
N = 5925.13
b = 400.00
δ'' = 0.12044818
Φy_comp = 1.7192695E-005
with fc = 20.00
Ec = 21019.039
ξy = 0.27904708
A = 0.01431084
B = 0.00808514
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

 - Calculation of θp -

From table 10-8: θp = 0.00468455
with:
 - Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
   shear control ratio VyE/VCol0E = 0.38885512
   d = 357.00
   s = 150.00
   ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = 0.00392699
   Av = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
   bw = 400.00
   The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
   where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
   All these variables have already been given in Shear control ratio calculation.
     NUD = 5925.13
     Ag = 160000.00
     f'cE = 20.00
     fytE = fylE = 444.4444
pl = Area_Tot_Long_Rein/(b*d) = 0.01443197
   b = 400.00
   d = 357.00
     f'cE = 20.00

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

Calculation No. 3

column C1, Floor 1

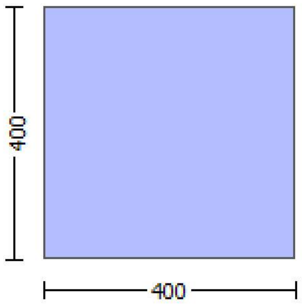
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

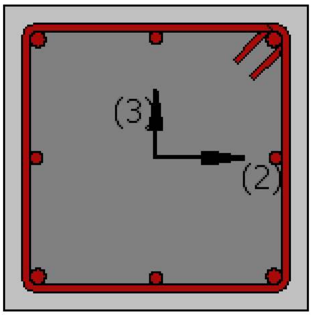
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)





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

Constant Properties

Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
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, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.4444
###
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed 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 = 2.3177645E-010
Shear Force, Va = 3.5573278E-014
EDGE -B-
Bending Moment, Mb = -3.3833429E-010
Shear Force, Vb = -3.5573278E-014
BOTH EDGES
Axial Force, F = -5925.13
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 829.3805
-Compression: Aslc = 1231.504
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239

Mean Diameter of Tension Reinforcement, DbL,ten = 18.66667

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = κ*Vn = 329787.837
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 329787.837
VCol = 329787.837
knl = 1.00
displacement_ductility_demand = 0.00

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

λ = 1 (normal-weight concrete)
fc' = 16.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 2.3177645E-010
Vu = 3.5573278E-014
d = 0.8*h = 320.00
Nu = 5925.13
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 201061.93
Av = 157079.633
fy = 400.00
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 340123.561
bw = 400.00

----
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 = 9.1020312E-021
θy = (My*Ls/3)/EIeff = 0.00508576 ((4.29),Biskinis Phd))
My = 1.3683E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3452E+013
factor = 0.30
Ag = 160000.00
fc' = 20.00
N = 5925.13
Ec*Ig = 4.4841E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 8.6431581E-006
with fy = 444.4444
d = 357.00
ξy = 0.27981045
A = 0.01452532
B = 0.00817849
with pt = 0.00580799
pc = 0.00580799
pv = 0.00281599
N = 5925.13

b = 400.00
δ" = 0.12044818
Φy_comp = 1.7192695E-005
with fc = 20.00
Ec = 21019.039
ξy = 0.27904708
A = 0.01431084
B = 0.00808514
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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

Calculation No. 4

column C1, Floor 1

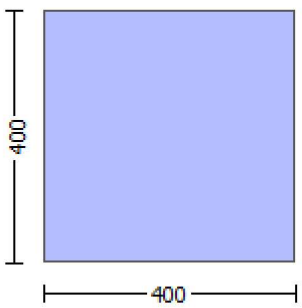
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

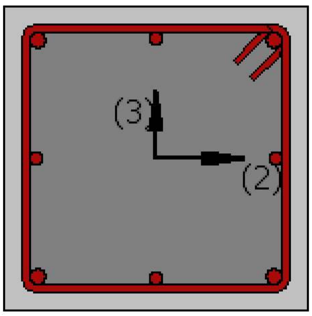
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (3)





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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.

Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
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
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
##
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.16547
Element Length, L = 3000.00
Primary Member
Ribbed 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 = 1.4743485E-030
EDGE -B-
Shear Force, Vb = -1.4743485E-030
BOTH EDGES
Axial Force, F = -5926.932
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.38885512
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 142781.295
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.1417E+008
Mu1+ = 2.1417E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.1417E+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-) = 2.1417E+008
Mu2+ = 2.1417E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.1417E+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 = 0.00010733
Mu = 2.1417E+008

----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481

εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00

ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556

with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00

fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture

δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 367183.782

Calculation of Shear Strength at edge 1, Vr1 = 367183.782
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.7295387E-012
Vu = 1.4743485E-030
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 367183.782
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.7295387E-012
Vu = 1.4743485E-030
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
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
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
##
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.16547
Element Length, L = 3000.00
Primary Member
Ribbed 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 = -9.0274828E-047
EDGE -B-
Shear Force, Vb = 9.0274828E-047
BOTH EDGES
Axial Force, F = -5926.932
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.38885512
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 142781.295
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.1417E+008
Mu1+ = 2.1417E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.1417E+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-) = 2.1417E+008
Mu2+ = 2.1417E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.1417E+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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575

The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699

Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469

λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 367183.782

Calculation of Shear Strength at edge 1, Vr1 = 367183.782
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 2.3349580E-013
Vu = 9.0274828E-047
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 367183.782
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 2.3349580E-013
Vu = 9.0274828E-047
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed 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 = -1.3509E+007
Shear Force, V2 = -4501.47
Shear Force, V3 = 3.5573278E-014
Axial Force, F = -5925.13
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 829.3805
-Compression: Aslc = 1231.504
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL = 18.66667

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = κ*θu = 0.01485984
θu = θy + θp = 0.01485984

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.01017529 ((4.29),Biskinis Phd))
My = 1.3683E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3001.112
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3452E+013
factor = 0.30
Ag = 160000.00
fc' = 20.00
N = 5925.13
Ec*Ig = 4.4841E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 8.6431581E-006
 with fy = 444.4444
      d = 357.00
      ξy = 0.27981045
      A = 0.01452532
      B = 0.00817849
       with pt = 0.00392699
            pc = 0.00580799
            pv = 0.00281599
            N = 5925.13
            b = 400.00
            δ'' = 0.12044818
Φy_comp = 1.7192695E-005
 with fc = 20.00
      Ec = 21019.039
      ξy = 0.27904708
      A = 0.01431084
      B = 0.00808514
       with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

 - Calculation of θp -

From table 10-8: θp = 0.00468455
with:
 - Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
   shear control ratio VyE/VCol0E = 0.38885512
   d = 357.00
   s = 150.00
   ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = 0.00392699
   Av = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
   bw = 400.00
   The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
   where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
   All these variables have already been given in Shear control ratio calculation.
     NUD = 5925.13
     Ag = 160000.00
     f'cE = 20.00
     fytE = fylE = 444.4444
pl = Area_Tot_Long_Rein/(b*d) = 0.01443197
   b = 400.00
   d = 357.00
     f'cE = 20.00

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

Calculation No. 5

column C1, Floor 1

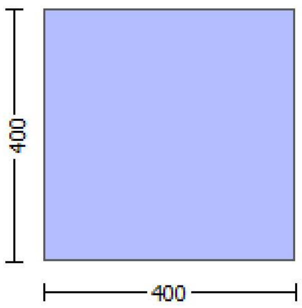
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

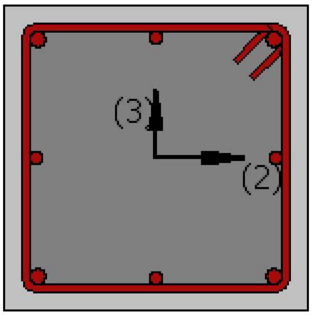
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)





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

Constant Properties

Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
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, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.4444
###
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed 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 = -1.3509E+007
Shear Force, Va = -4501.47
EDGE -B-
Bending Moment, Mb = 0.06798356
Shear Force, Vb = 4501.47
BOTH EDGES
Axial Force, F = -5925.13
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 18.66667

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = κ*Vn = 329787.837
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 329787.837
VCol = 329787.837
knl = 1.00
displacement_ductility_demand = 0.14808284

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

λ = 1 (normal-weight concrete)
fc' = 16.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.06798356
Vu = 4501.47
d = 0.8*h = 320.00
Nu = 5925.13
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 201061.93
Av = 157079.633
fy = 400.00
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 340123.561
bw = 400.00

----
displacement_ductility_demand is calculated as θ/θy

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

From analysis, chord rotation θ = 0.00015062
θy = (My*Ls/3)/Eleff = 0.00101715 ((4.29),Biskinis Phd))
My = 1.3683E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 1.3452E+013
factor = 0.30
Ag = 160000.00
fc' = 20.00

N = 5925.13
Ec*Ig = 4.4841E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 8.6431581E-006
with fy = 444.4444
d = 357.00
ξy = 0.27981045
A = 0.01452532
B = 0.00817849
with pt = 0.00580799
pc = 0.00580799
pv = 0.00281599
N = 5925.13
b = 400.00
δ" = 0.12044818
Φy_comp = 1.7192695E-005
with fc = 20.00
Ec = 21019.039
ξy = 0.27904708
A = 0.01431084
B = 0.00808514
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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

Calculation No. 6

column C1, Floor 1

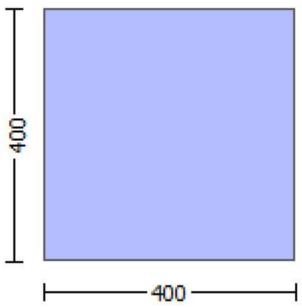
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

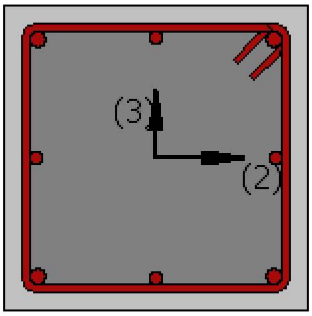
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (2)





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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
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
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
###
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.16547
Element Length, L = 3000.00
Primary Member
Ribbed 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 = 1.4743485E-030
EDGE -B-
Shear Force, Vb = -1.4743485E-030
BOTH EDGES
Axial Force, F = -5926.932
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.38885512
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 142781.295
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.1417E+008
Mu1+ = 2.1417E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.1417E+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-) = 2.1417E+008
Mu2+ = 2.1417E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.1417E+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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526

N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982

No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00

d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 367183.782

Calculation of Shear Strength at edge 1, Vr1 = 367183.782
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.7295387E-012
Vu = 1.4743485E-030
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 367183.782
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.7295387E-012
Vu = 1.4743485E-030

d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
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
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
##
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.16547
Element Length, L = 3000.00
Primary Member
Ribbed 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 = -9.0274828E-047
EDGE -B-
Shear Force, Vb = 9.0274828E-047
BOTH EDGES
Axial Force, F = -5926.932
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805

-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.38885512
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 142781.295
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.1417E+008
Mu1+ = 2.1417E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.1417E+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-) = 2.1417E+008
Mu2+ = 2.1417E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.1417E+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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556

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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667

fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----

with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008

ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00

Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00

ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 367183.782

Calculation of Shear Strength at edge 1, Vr1 = 367183.782
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 2.3349580E-013
Vu = 9.0274828E-047
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 367183.782
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 2.3349580E-013
Vu = 9.0274828E-047
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed 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 = -3.3833429E-010
Shear Force, V2 = 4501.47
Shear Force, V3 = -3.5573278E-014
Axial Force, F = -5925.13
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL = 18.66667

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = κ*θu = 0.00977031
θu = θy + θp = 0.00977031

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00508576 ((4.29),Biskinis Phd))
My = 1.3683E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3452E+013
factor = 0.30
Ag = 160000.00
fc' = 20.00
N = 5925.13
Ec*Ig = 4.4841E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 8.6431581E-006
with fy = 444.4444
d = 357.00
ξy = 0.27981045
A = 0.01452532
B = 0.00817849
with pt = 0.00392699
pc = 0.00580799
pv = 0.00281599
N = 5925.13
b = 400.00
δ'' = 0.12044818
Φy_comp = 1.7192695E-005
with fc = 20.00
Ec = 21019.039
ξy = 0.27904708
A = 0.01431084
B = 0.00808514
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

- Calculation of θp -

From table 10-8: θp = 0.00468455
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VColOE = 0.38885512
d = 357.00
s = 150.00
ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = 0.00392699
Av = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
bw = 400.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.

NUD = 5925.13
Ag = 160000.00
f'cE = 20.00
fytE = fylE = 444.4444
pl = Area_Tot_Long_Rein/(b*d) = 0.01443197
b = 400.00
d = 357.00
f'cE = 20.00

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

Calculation No. 7

column C1, Floor 1

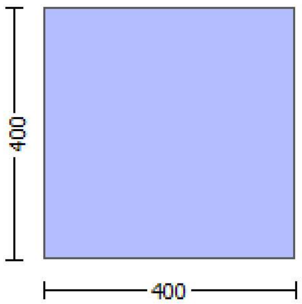
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

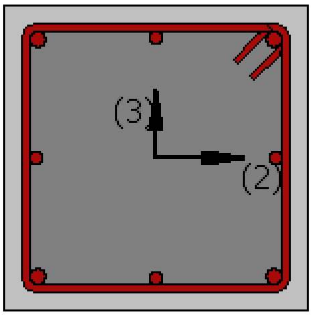
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)





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

Constant Properties

Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Concrete Elasticity, Ec = 21019.039
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, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.4444
##
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed 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 = 2.3177645E-010
Shear Force, Va = 3.5573278E-014
EDGE -B-
Bending Moment, Mb = -3.3833429E-010
Shear Force, Vb = -3.5573278E-014
BOTH EDGES
Axial Force, F = -5925.13
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 18.66667

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = κ*Vn = 329787.837
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 329787.837
VCol = 329787.837
knl = 1.00
displacement_ductility_demand = 0.00

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

λ = 1 (normal-weight concrete)
fc' = 16.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 3.3833429E-010
Vu = 3.5573278E-014
d = 0.8*h = 320.00
Nu = 5925.13
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 201061.93
Av = 157079.633
fy = 400.00
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125

Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 340123.561
bw = 400.00

----
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 = 9.4539705E-021
θy = (My*Ls/3)/EIeff = 0.00508576 ((4.29),Biskinis Phd))
My = 1.3683E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3452E+013
factor = 0.30
Ag = 160000.00
fc' = 20.00
N = 5925.13
Ec*Ig = 4.4841E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 8.6431581E-006
with fy = 444.4444
d = 357.00
ξy = 0.27981045
A = 0.01452532
B = 0.00817849
with pt = 0.00580799
pc = 0.00580799
pv = 0.00281599
N = 5925.13
b = 400.00
δ'' = 0.12044818
Φy_comp = 1.7192695E-005
with fc = 20.00
Ec = 21019.039
ξy = 0.27904708
A = 0.01431084
B = 0.00808514
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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

Calculation No. 8

column C1, Floor 1

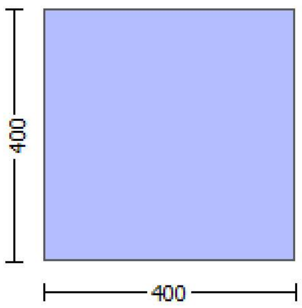
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

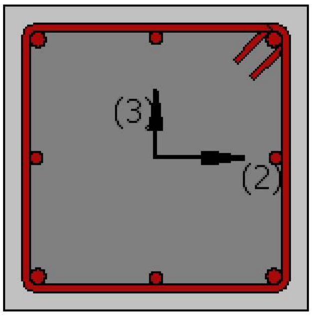
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (3)





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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
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
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
##
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.16547
Element Length, L = 3000.00
Primary Member
Ribbed 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 = 1.4743485E-030
EDGE -B-
Shear Force, Vb = -1.4743485E-030
BOTH EDGES
Axial Force, F = -5926.932
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.38885512
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 142781.295
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.1417E+008
Mu1+ = 2.1417E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.1417E+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-) = 2.1417E+008
Mu2+ = 2.1417E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.1417E+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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00

----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00

fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556

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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667

fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----

with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008

ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 367183.782

Calculation of Shear Strength at edge 1, Vr1 = 367183.782
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.7295387E-012
Vu = 1.4743485E-030
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00

Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 367183.782
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.7295387E-012
Vu = 1.4743485E-030
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
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
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
###
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.16547
Element Length, L = 3000.00
Primary Member
Ribbed 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 = -9.0274828E-047
EDGE -B-
Shear Force, Vb = 9.0274828E-047
BOTH EDGES
Axial Force, F = -5926.932
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.38885512
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 142781.295
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.1417E+008
Mu1+ = 2.1417E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.1417E+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-) = 2.1417E+008
Mu2+ = 2.1417E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.1417E+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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699

----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469

λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied

--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.

with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 367183.782

Calculation of Shear Strength at edge 1, Vr1 = 367183.782
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 2.3349580E-013
Vu = 9.0274828E-047
d = 0.8*h = 320.00
Nu = 5926.932

Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 367183.782
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 2.3349580E-013
Vu = 9.0274828E-047
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed 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 = 0.06798356
Shear Force, V2 = 4501.47
Shear Force, V3 = -3.5573278E-014
Axial Force, F = -5925.13
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL = 18.66667

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = κ*θu = 0.0057017
θu = θy + θp = 0.0057017

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00101715 ((4.29),Biskinis Phd))
My = 1.3683E+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 = 1.3452E+013
factor = 0.30
Ag = 160000.00
fc' = 20.00
N = 5925.13
Ec*Ig = 4.4841E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 8.6431581E-006
with fy = 444.4444
d = 357.00
ξy = 0.27981045
A = 0.01452532
B = 0.00817849
with pt = 0.00392699
pc = 0.00580799
pv = 0.00281599
N = 5925.13
b = 400.00
δ'' = 0.12044818
Φy_comp = 1.7192695E-005
with fc = 20.00
Ec = 21019.039
ξy = 0.27904708
A = 0.01431084
B = 0.00808514
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

- Calculation of θp -

From table 10-8: θp = 0.00468455
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
  shear control ratio VyE/VCol0E = 0.38885512
  d = 357.00
  s = 150.00
  ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = 0.00392699
  Av = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
  bw = 400.00
  The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
  where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
  All these variables have already been given in Shear control ratio calculation.
    NUD = 5925.13
    Ag = 160000.00
    f'cE = 20.00
    fytE = fylE = 444.4444

pl = Area_Tot_Long_Rein/(b*d) = 0.01443197
  b = 400.00
  d = 357.00
    f'cE = 20.00

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

Calculation No. 9

column C1, Floor 1

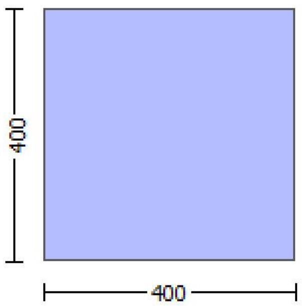
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

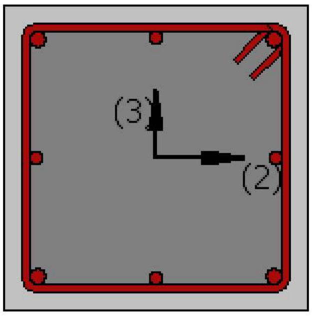
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)





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

Constant Properties

Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
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, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.4444
###
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed 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 = -1.6898E+007
Shear Force, Va = -5630.434
EDGE -B-
Bending Moment, Mb = 0.08503377
Shear Force, Vb = 5630.434
BOTH EDGES
Axial Force, F = -5924.679
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 829.3805
-Compression: Aslc = 1231.504
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239

Mean Diameter of Tension Reinforcement, DbL,ten = 18.66667

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = κ*Vn = 265424.838
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 265424.838
VCol = 265424.838
knl = 1.00
displacement_ductility_demand = 0.03475979

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

λ = 1 (normal-weight concrete)
fc' = 16.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
Mu = 1.6898E+007
Vu = 5630.434
d = 0.8*h = 320.00
Nu = 5924.679
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 201061.93
Av = 157079.633
fy = 400.00
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 340123.561
bw = 400.00

----
displacement_ductility_demand is calculated as θ/θy

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

From analysis, chord rotation θ = 0.00035369
θy = (My*Ls/3)/EIeff = 0.01017529 ((4.29),Biskinis Phd))
My = 1.3683E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3001.112
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3452E+013
factor = 0.30
Ag = 160000.00
fc' = 20.00
N = 5924.679
Ec*Ig = 4.4841E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 8.6431567E-006
with fy = 444.4444
d = 357.00
ξy = 0.27981033
A = 0.01452532
B = 0.00817849
with pt = 0.00580799
pc = 0.00580799
pv = 0.00281599
N = 5924.679

b = 400.00
δ" = 0.12044818
Φy_comp = 1.7192698E-005
with fc = 20.00
Ec = 21019.039
ξy = 0.27904702
A = 0.01431085
B = 0.00808514
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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

Calculation No. 10

column C1, Floor 1

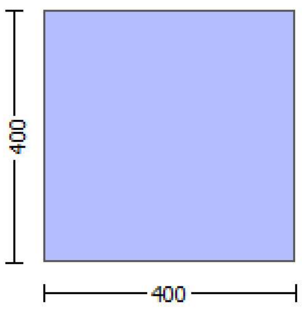
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

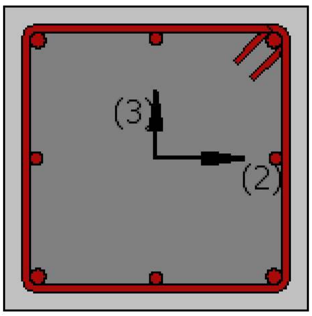
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (2)





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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.

Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
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
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
##
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.16547
Element Length, L = 3000.00
Primary Member
Ribbed 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 = 1.4743485E-030
EDGE -B-
Shear Force, Vb = -1.4743485E-030
BOTH EDGES
Axial Force, F = -5926.932
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.38885512
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 142781.295
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.1417E+008
Mu1+ = 2.1417E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.1417E+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-) = 2.1417E+008
Mu2+ = 2.1417E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.1417E+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 = 0.00010733
Mu = 2.1417E+008

----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481

εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00

ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556

with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00

fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture

δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 367183.782

Calculation of Shear Strength at edge 1, Vr1 = 367183.782
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.7295387E-012
Vu = 1.4743485E-030
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 367183.782
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.7295387E-012
Vu = 1.4743485E-030
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
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
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
###
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.16547
Element Length, L = 3000.00
Primary Member
Ribbed 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 = -9.0274828E-047
EDGE -B-
Shear Force, Vb = 9.0274828E-047
BOTH EDGES
Axial Force, F = -5926.932
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.38885512
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 142781.295
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.1417E+008
Mu1+ = 2.1417E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.1417E+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-) = 2.1417E+008
Mu2+ = 2.1417E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.1417E+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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575

The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699

Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469

λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 367183.782

Calculation of Shear Strength at edge 1, Vr1 = 367183.782
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 2.3349580E-013
Vu = 9.0274828E-047
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 367183.782
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 2.3349580E-013
Vu = 9.0274828E-047
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed 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 = 2.8947200E-010
Shear Force, V2 = -5630.434
Shear Force, V3 = 4.4495023E-014
Axial Force, F = -5924.679
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 829.3805
-Compression: Aslc = 1231.504
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL = 18.66667

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = κ*θu = 0.02070093
θu = θy + θp = 0.02070093

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00508576 ((4.29),Biskinis Phd))
My = 1.3683E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3452E+013
factor = 0.30
Ag = 160000.00
fc' = 20.00
N = 5924.679
Ec*Ig = 4.4841E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 8.6431567E-006
with fy = 444.4444
d = 357.00
ξy = 0.27981033
A = 0.01452532
B = 0.00817849
with pt = 0.00392699
pc = 0.00580799
pv = 0.00281599
N = 5924.679
b = 400.00
δ'' = 0.12044818
Φy_comp = 1.7192698E-005
with fc = 20.00
Ec = 21019.039
ξy = 0.27904702
A = 0.01431085
B = 0.00808514
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

- Calculation of θp -

From table 10-8: θp = 0.01561517
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.38885512
d = 357.00
s = 150.00
ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = 0.00392699
Av = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
bw = 400.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
NUD = 5924.679
Ag = 160000.00
f'cE = 20.00
fytE = fylE = 444.4444
pl = Area_Tot_Long_Rein/(b*d) = 0.01443197
b = 400.00
d = 357.00
f'cE = 20.00

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

Calculation No. 11

column C1, Floor 1

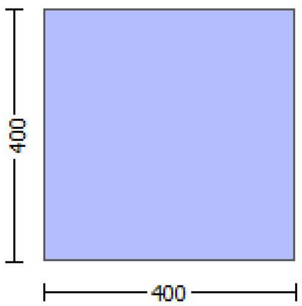
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

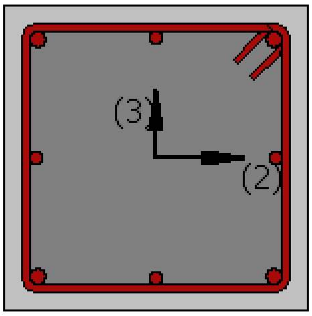
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)





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

Constant Properties

Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
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, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.4444
###
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed 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 = 2.8947200E-010
Shear Force, Va = 4.4495023E-014
EDGE -B-
Bending Moment, Mb = -4.2275445E-010
Shear Force, Vb = -4.4495023E-014
BOTH EDGES
Axial Force, F = -5924.679
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 829.3805
-Compression: Aslc = 1231.504
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 18.66667

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = κ*Vn = 329787.747
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 329787.747
VCol = 329787.747
knl = 1.00
displacement_ductility_demand = 0.00

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

λ = 1 (normal-weight concrete)
fc' = 16.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 2.8947200E-010
Vu = 4.4495023E-014
d = 0.8*h = 320.00
Nu = 5924.679
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 201061.93
Av = 157079.633
fy = 400.00
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 340123.561
bw = 400.00

----
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 = 1.1384812E-020
θy = (My*Ls/3)/EIeff = 0.00508576 ((4.29),Biskinis Phd))
My = 1.3683E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3452E+013
factor = 0.30
Ag = 160000.00
fc' = 20.00

N = 5924.679
Ec*Ig = 4.4841E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 8.6431567E-006
with fy = 444.4444
d = 357.00
ξy = 0.27981033
A = 0.01452532
B = 0.00817849
with pt = 0.00580799
pc = 0.00580799
pv = 0.00281599
N = 5924.679
b = 400.00
δ" = 0.12044818
Φy_comp = 1.7192698E-005
with fc = 20.00
Ec = 21019.039
ξy = 0.27904702
A = 0.01431085
B = 0.00808514
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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

Calculation No. 12

column C1, Floor 1

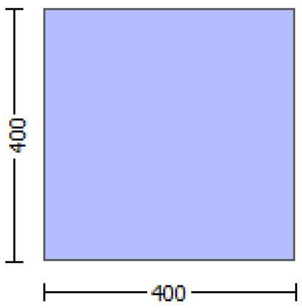
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

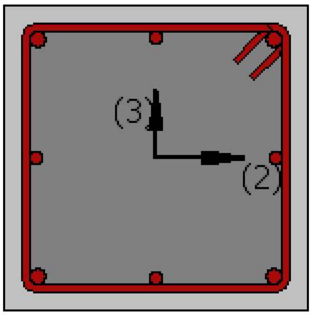
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (3)





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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
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
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
###
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.16547
Element Length, L = 3000.00
Primary Member
Ribbed 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 = 1.4743485E-030
EDGE -B-
Shear Force, Vb = -1.4743485E-030
BOTH EDGES
Axial Force, F = -5926.932
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.38885512
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 142781.295
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.1417E+008
Mu1+ = 2.1417E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.1417E+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-) = 2.1417E+008
Mu2+ = 2.1417E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.1417E+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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526

N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982

No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00

d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 367183.782

Calculation of Shear Strength at edge 1, Vr1 = 367183.782
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.7295387E-012
Vu = 1.4743485E-030
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 367183.782
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.7295387E-012
Vu = 1.4743485E-030

d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
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
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
###
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.16547
Element Length, L = 3000.00
Primary Member
Ribbed 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 = -9.0274828E-047
EDGE -B-
Shear Force, Vb = 9.0274828E-047
BOTH EDGES
Axial Force, F = -5926.932
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805

-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.38885512
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 142781.295
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.1417E+008
Mu1+ = 2.1417E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.1417E+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-) = 2.1417E+008
Mu2+ = 2.1417E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.1417E+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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556

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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667

fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----

with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008

ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00

Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00

ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 367183.782

Calculation of Shear Strength at edge 1, Vr1 = 367183.782
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 2.3349580E-013
Vu = 9.0274828E-047
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 367183.782
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 2.3349580E-013
Vu = 9.0274828E-047
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed 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 = -1.6898E+007
Shear Force, V2 = -5630.434
Shear Force, V3 = 4.4495023E-014
Axial Force, F = -5924.679
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 829.3805
-Compression: Aslc = 1231.504
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL = 18.66667

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = κ*θu = 0.02579046
θu = θy + θp = 0.02579046

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.01017529 ((4.29),Biskinis Phd))
My = 1.3683E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3001.112
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3452E+013
factor = 0.30
Ag = 160000.00
fc' = 20.00
N = 5924.679
Ec*Ig = 4.4841E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 8.6431567E-006
with fy = 444.4444
d = 357.00
ξy = 0.27981033
A = 0.01452532
B = 0.00817849
with pt = 0.00392699
pc = 0.00580799
pv = 0.00281599
N = 5924.679
b = 400.00
δ'' = 0.12044818
Φy_comp = 1.7192698E-005
with fc = 20.00
Ec = 21019.039
ξy = 0.27904702
A = 0.01431085
B = 0.00808514
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

- Calculation of θp -

From table 10-8: θp = 0.01561517
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.38885512
d = 357.00
s = 150.00
ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = 0.00392699
Av = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
bw = 400.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.

NUD = 5924.679
Ag = 160000.00
f'cE = 20.00
fytE = fylE = 444.4444
pl = Area_Tot_Long_Rein/(b*d) = 0.01443197
b = 400.00
d = 357.00
f'cE = 20.00

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

Calculation No. 13

column C1, Floor 1

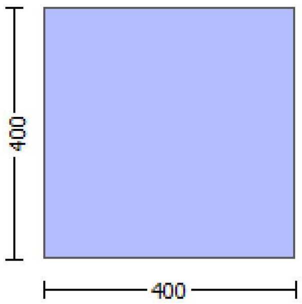
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

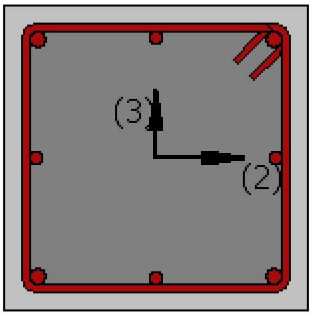
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)





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

Constant Properties

Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00

Concrete Elasticity, Ec = 21019.039
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, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.4444
###
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed 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 = -1.6898E+007
Shear Force, Va = -5630.434
EDGE -B-
Bending Moment, Mb = 0.08503377
Shear Force, Vb = 5630.434
BOTH EDGES
Axial Force, F = -5924.679
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 18.66667

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = κ*Vn = 329787.747
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 329787.747
VCol = 329787.747
knl = 1.00
displacement_ductility_demand = 0.18522197

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

λ = 1 (normal-weight concrete)
fc' = 16.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.08503377
Vu = 5630.434
d = 0.8*h = 320.00
Nu = 5924.679
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 201061.93
Av = 157079.633
fy = 400.00
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125

Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 340123.561
bw = 400.00

----
displacement_ductility_demand is calculated as θ/θy

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

From analysis, chord rotation θ = 0.0001884
θy = (My*Ls/3)/EIeff = 0.00101715 ((4.29),Biskinis Phd))
My = 1.3683E+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 = 1.3452E+013
factor = 0.30
Ag = 160000.00
fc' = 20.00
N = 5924.679
Ec*Ig = 4.4841E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 8.6431567E-006
with fy = 444.4444
d = 357.00
ξy = 0.27981033
A = 0.01452532
B = 0.00817849
with pt = 0.00580799
pc = 0.00580799
pv = 0.00281599
N = 5924.679
b = 400.00
δ'' = 0.12044818
Φy_comp = 1.7192698E-005
with fc = 20.00
Ec = 21019.039
ξy = 0.27904702
A = 0.01431085
B = 0.00808514
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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

Calculation No. 14

column C1, Floor 1

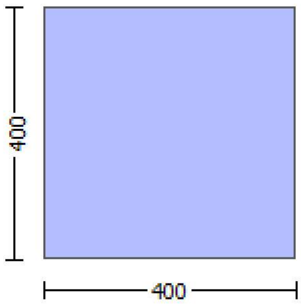
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

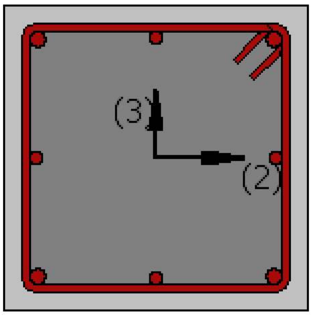
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (2)





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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
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
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
##
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.16547
Element Length, L = 3000.00
Primary Member
Ribbed 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 = 1.4743485E-030
EDGE -B-
Shear Force, Vb = -1.4743485E-030
BOTH EDGES
Axial Force, F = -5926.932
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.38885512
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 142781.295
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.1417E+008
Mu1+ = 2.1417E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.1417E+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-) = 2.1417E+008
Mu2+ = 2.1417E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.1417E+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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00

----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00

fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556

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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667

fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----

with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008

ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 367183.782

Calculation of Shear Strength at edge 1, Vr1 = 367183.782
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.7295387E-012
Vu = 1.4743485E-030
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00

Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 367183.782
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.7295387E-012
Vu = 1.4743485E-030
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
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
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
##
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.16547
Element Length, L = 3000.00
Primary Member
Ribbed 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 = -9.0274828E-047
EDGE -B-
Shear Force, Vb = 9.0274828E-047
BOTH EDGES
Axial Force, F = -5926.932
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.38885512
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 142781.295
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.1417E+008
Mu1+ = 2.1417E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.1417E+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-) = 2.1417E+008
Mu2+ = 2.1417E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.1417E+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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699

----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469

λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied

--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
$\varphi u = \varphi su$ (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu^* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
$\Sigma bi2$ = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
$\varepsilon y1$ = 0.00231481
$\varepsilon sh1$ = 0.008
ft1 = 666.6667
fy1 = 555.5556
$\varepsilon su1$ = 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
$\varepsilon su1$ = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and $\varepsilon y1$,$\varepsilon sh1$,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
$\varepsilon y1$,$\varepsilon sh1$,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.

with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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.

$\varepsilon y1, \varepsilon sh1, ft1, fy1$, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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 $\varepsilon yv, \varepsilon shv$,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
$\varepsilon y1, \varepsilon sh1$,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
$\omega 1$ = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
$\omega 2$ = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
$\omega 1$ = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
$\omega 2$ = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
$\varphi u = \varphi su$ (4.1) = 0.00010733

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 367183.782

Calculation of Shear Strength at edge 1, Vr1 = 367183.782
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 2.3349580E-013
Vu = 9.0274828E-047
d = 0.8*h = 320.00
Nu = 5926.932

Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 367183.782
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 2.3349580E-013
Vu = 9.0274828E-047
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed 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 = -4.2275445E-010
Shear Force, V2 = 5630.434
Shear Force, V3 = -4.4495023E-014
Axial Force, F = -5924.679
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL = 18.66667

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = κ*θu = 0.02070093
θu = θy + θp = 0.02070093

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00508576 ((4.29),Biskinis Phd))
My = 1.3683E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3452E+013
factor = 0.30
Ag = 160000.00
fc' = 20.00
N = 5924.679
Ec*Ig = 4.4841E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 8.6431567E-006
with fy = 444.4444
d = 357.00
ξy = 0.27981033
A = 0.01452532
B = 0.00817849
with pt = 0.00392699
pc = 0.00580799
pv = 0.00281599
N = 5924.679
b = 400.00
δ'' = 0.12044818
Φy_comp = 1.7192698E-005
with fc = 20.00
Ec = 21019.039
ξy = 0.27904702
A = 0.01431085
B = 0.00808514
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

- Calculation of θp -

From table 10-8: θp = 0.01561517
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.38885512
d = 357.00
s = 150.00
ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = 0.00392699
Av = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
bw = 400.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
NUD = 5924.679
Ag = 160000.00
f'cE = 20.00
fytE = fylE = 444.4444
pl = Area_Tot_Long_Rein/(b*d) = 0.01443197
b = 400.00
d = 357.00
f'cE = 20.00

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

Calculation No. 15

column C1, Floor 1

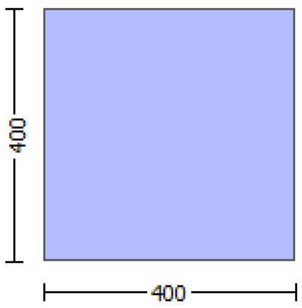
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

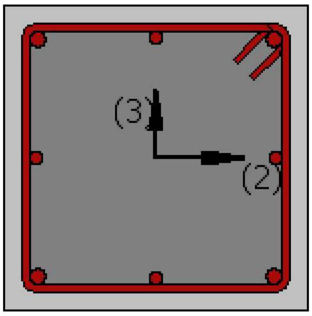
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)





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

Constant Properties

Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
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, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.4444
###
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed 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 = 2.8947200E-010
Shear Force, Va = 4.4495023E-014
EDGE -B-
Bending Moment, Mb = -4.2275445E-010
Shear Force, Vb = -4.4495023E-014
BOTH EDGES
Axial Force, F = -5924.679
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239

Mean Diameter of Tension Reinforcement, DbL,ten = 18.66667

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = κ*Vn = 329787.747
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 329787.747
VCol = 329787.747
knl = 1.00
displacement_ductility_demand = 0.00

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

λ = 1 (normal-weight concrete)
fc' = 16.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.2275445E-010
Vu = 4.4495023E-014
d = 0.8*h = 320.00
Nu = 5924.679
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 201061.93
Av = 157079.633
fy = 400.00
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 340123.561
bw = 400.00

----
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 = 1.1825017E-020
θy = (My*Ls/3)/EIeff = 0.00508576 ((4.29),Biskinis Phd))
My = 1.3683E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3452E+013
factor = 0.30
Ag = 160000.00
fc' = 20.00
N = 5924.679
Ec*Ig = 4.4841E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 8.6431567E-006
with fy = 444.4444
d = 357.00
ξy = 0.27981033
A = 0.01452532
B = 0.00817849
with pt = 0.00580799
pc = 0.00580799
pv = 0.00281599
N = 5924.679

b = 400.00
δ" = 0.12044818
Φy_comp = 1.7192698E-005
with fc = 20.00
Ec = 21019.039
ξy = 0.27904702
A = 0.01431085
B = 0.00808514
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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

Calculation No. 16

column C1, Floor 1

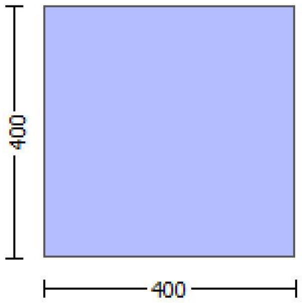
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

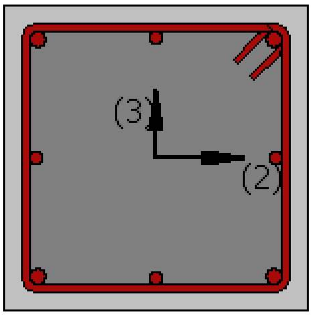
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (3)





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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.

Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
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
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
##
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.16547
Element Length, L = 3000.00
Primary Member
Ribbed 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 = 1.4743485E-030
EDGE -B-
Shear Force, Vb = -1.4743485E-030
BOTH EDGES
Axial Force, F = -5926.932
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.38885512
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 142781.295
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.1417E+008
Mu1+ = 2.1417E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.1417E+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-) = 2.1417E+008
Mu2+ = 2.1417E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.1417E+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 = 0.00010733
Mu = 2.1417E+008

----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481

εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00

ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556

with $E_{sv} = E_s = 200000.00$
$\omega_1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.16133296$
$\omega_2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.16133296$
$\omega_v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.07822204$
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
$\omega_1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.20721664$
$\omega_2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.20721664$
$\omega_v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.10046867$
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00

fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture

δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 367183.782

Calculation of Shear Strength at edge 1, Vr1 = 367183.782
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.7295387E-012
Vu = 1.4743485E-030
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 367183.782
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.7295387E-012
Vu = 1.4743485E-030
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
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
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
###
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.16547
Element Length, L = 3000.00
Primary Member
Ribbed 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 = -9.0274828E-047
EDGE -B-
Shear Force, Vb = 9.0274828E-047
BOTH EDGES
Axial Force, F = -5926.932
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.38885512
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 142781.295
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.1417E+008
Mu1+ = 2.1417E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.1417E+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-) = 2.1417E+008
Mu2+ = 2.1417E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.1417E+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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575

The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699

----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00

----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00

----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699

Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469

λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

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 = 0.00010733
Mu = 2.1417E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00207526
N = 5926.932
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01000575
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01000575
ωwe (5.4c) = 0.02645296
ase ((5.4d), TBDY) = 0.24250288
bo = 340.00
ho = 340.00
Σbi2 = 462400.00
psh,min = Min(psh,x , psh,y) = 0.00392699
----
psh,x (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
psh,y (5.4d) = 0.00392699
Ash = Astir*ns = 78.53982
No stirups, ns = 2.00
bk = 400.00
----
s = 100.00
fywe = 555.5556
fce = 20.00
From ((5.A5), TBDY), TBDY: εcc = 0.00365469
λc = confinement factor = 1.16547
εy1 = 0.00231481
εsh1 = 0.008
ft1 = 666.6667
fy1 = 555.5556
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, ASCE 41-17.
with fs1 = fs = 555.5556
with Es1 = Es = 200000.00
εy2 = 0.00231481
εsh2 = 0.008
ft2 = 666.6667
fy2 = 555.5556
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, ASCE 41-17.
with fs2 = fs = 555.5556
with Es2 = Es = 200000.00
εyv = 0.00231481
εshv = 0.008
ftv = 666.6667
fyv = 555.5556
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, ASCE 41-17.
with fsv = fs = 555.5556
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.16133296
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16133296
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07822204
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 23.30938
εcc (5A.5, TBDY) = 0.00365469
λc = confinement factor = 1.16547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.20721664
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.20721664
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.10046867
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16484553
Mu = MRc (4.14) = 2.1417E+008
φu = φsu (4.1) = 0.00010733

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 367183.782

Calculation of Shear Strength at edge 1, Vr1 = 367183.782
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 2.3349580E-013
Vu = 9.0274828E-047
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 367183.782
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 367183.782
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 2.3349580E-013
Vu = 9.0274828E-047
d = 0.8*h = 320.00
Nu = 5926.932
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = 223402.144
Av = 157079.633
fy = 444.4444
s = 100.00
Vs is multiplied by αCol = 1.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 380269.701
bw = 400.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
Section Height, H = 400.00
Section Width, W = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed 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 = 0.08503377
Shear Force, V2 = 5630.434
Shear Force, V3 = -4.4495023E-014
Axial Force, F = -5924.679
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2060.885
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 829.3805
-Compression: Asl,com = 829.3805
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL = 18.66667

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = κ*θu = 0.01663232
θu = θy + θp = 0.01663232

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00101715 ((4.29),Biskinis Phd))
My = 1.3683E+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 = 1.3452E+013
factor = 0.30
Ag = 160000.00
fc' = 20.00
N = 5924.679
Ec*Ig = 4.4841E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 8.6431567E-006
with fy = 444.4444
d = 357.00
ξy = 0.27981033
A = 0.01452532
B = 0.00817849
with pt = 0.00392699
pc = 0.00580799
pv = 0.00281599
N = 5924.679
b = 400.00
δ" = 0.12044818
Φy_comp = 1.7192698E-005
with fc = 20.00
Ec = 21019.039
ξy = 0.27904702
A = 0.01431085
B = 0.00808514
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

- Calculation of θp -

From table 10-8: θp = 0.01561517
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.38885512
d = 357.00
s = 150.00
ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = 0.00392699
Av = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
bw = 400.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
NUD = 5924.679
Ag = 160000.00
f'cE = 20.00
fytE = fylE = 444.4444
pl = Area_Tot_Long_Rein/(b*d) = 0.01443197
b = 400.00
d = 357.00
f'cE = 20.00

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