Detailed Member Calculations

Units: N&mm

Regulation: ASCE 41-17

Calculation No. 1

column C1, Floor 1

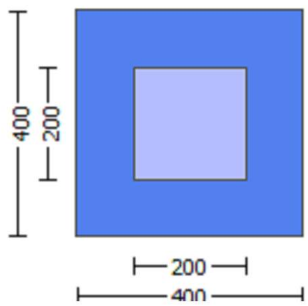
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

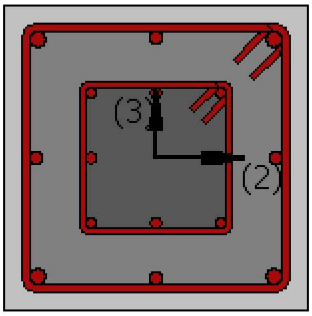
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)





Start Of Calculation of Shear Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcjrs

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:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -2.0483E+007
Shear Force, Va = -6825.705
EDGE -B-
Bending Moment, Mb = -0.01979425
Shear Force, Vb = 6825.705
BOTH EDGES
Axial Force, F = -6023.953
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1291.195
-Compression: Aslc = 2001.195
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999
Mean Diameter of Tension Reinforcement, DbL,ten = 16.33333

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 331644.008
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 331644.008
VCol = 331644.008
knl = 1.00
displacement_ductility_demand = 0.0460526

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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)

M/Vd = 4.00
Mu = 2.0483E+007
Vu = 6825.705
d = 0.8*h = 320.00
Nu = 6023.953
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
where:
Vs1 = 251327.412 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 500.00
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 425154.451
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 = 0.00033528
θy = (My*Ls/3)/EIeff = 0.00728036 ((4.29),Biskinis Phd))
My = 1.2576E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3000.884
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 6023.953
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.2162520E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 260.4851
d = 357.00
ξy = 0.30059914
A = 0.02321789
B = 0.01307844
with pt = 0.00904198
pc = 0.00904198
pv = 0.00497199
N = 6023.953
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.0592201E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29926824

A = 0.02296007
B = 0.0129165
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.22972747
lb = 300.00
ld = 1305.895
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 555.56
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

End Of Calculation of Shear Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 2

column C1, Floor 1

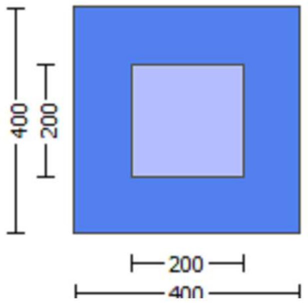
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

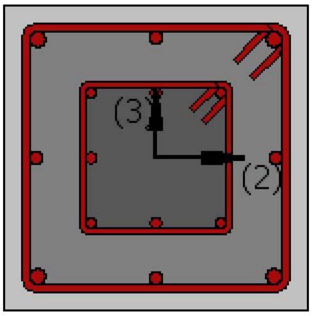
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (2)





Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjrs

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03547
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -1.0996693E-030
EDGE -B-
Shear Force, Vb = 1.0996693E-030
BOTH EDGES

Axial Force, F = -6026.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999

Calculation of Shear Capacity ratio , Ve/Vr = 0.21205453
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 98315.01
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4747E+008
Mu1+ = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4747E+008
Mu2+ = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00

h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617

---

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

---

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699

Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 463630.789

Calculation of Shear Strength at edge 1, Vr1 = 463630.789
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.7987490E-012
Vu = 1.0996693E-030
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:

Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 463630.789
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.7987490E-012
Vu = 1.0996693E-030
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjrs

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03547
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 6.7333103E-047
EDGE -B-
Shear Force, Vb = -6.7333103E-047
BOTH EDGES
Axial Force, F = -6026.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999

Calculation of Shear Capacity ratio , Ve/Vr = 0.21205453
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 98315.01
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4747E+008
Mu1+ = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

Mu1- = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4747E+008
Mu2+ = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471

λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied

--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265

Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered

characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis

s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189

fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 463630.789

Calculation of Shear Strength at edge 1, Vr1 = 463630.789
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0970837E-012
Vu = 6.7333103E-047
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 463630.789
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0970837E-012
Vu = 6.7333103E-047
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcjrs

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:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00

Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping

Stepwise Properties

Bending Moment, M = 1.6113210E-009
Shear Force, V2 = -6825.705
Shear Force, V3 = -5.9576024E-013
Axial Force, F = -6023.953
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1291.195
-Compression: Aslc = 2001.195
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 829.3805
-Compression: Asl,com,jacket = 829.3805
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 461.8141
-Compression: Asl,com,core = 461.8141
-Middle: Asl,mid,core = 307.8761
Mean Diameter of Tension Reinforcement, DbL = 16.33333

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00363911
θu = θy + θp = 0.00363911

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00363911 ((4.29),Biskinis Phd))
My = 1.2576E+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 = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 6023.953
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.2162520E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 260.4851
d = 357.00
ξy = 0.30059914
A = 0.02321789

B = 0.01307844
with pt = 0.00442965
pc = 0.00904198
pv = 0.00497199
N = 6023.953
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.0592201E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29926824
A = 0.02296007
B = 0.0129165
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.22972747
lb = 300.00
ld = 1305.895
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 555.56
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

- Calculation of θp -

From table 10-8: θp = 0.00
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
shear control ratio VyE/VCol0E = 0.21205453
d = d_external = 357.00
s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00442965
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00392699
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 400.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00050265
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 200.00
s2 = 250.00
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.
For the normalisation fs of jacket is used.
NUD = 6023.953
Ag = 160000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein =

555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.02305595
b = 400.00
d = 357.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 3

column C1, Floor 1

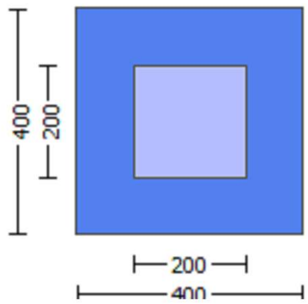
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

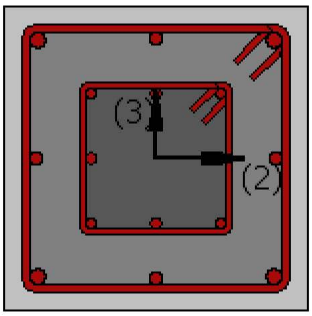
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)





Start Of Calculation of Shear Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rcjrs

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:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
###
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = 1.6113210E-009
Shear Force, Va = -5.9576024E-013
EDGE -B-
Bending Moment, Mb = 1.7638548E-010
Shear Force, Vb = 5.9576024E-013
BOTH EDGES
Axial Force, F = -6023.953
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1291.195
-Compression: Aslc = 2001.195
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999
Mean Diameter of Tension Reinforcement, DbL,ten = 16.33333

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 411960.604
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 411960.604
VCol = 411960.604
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.6113210E-009

Vu = 5.9576024E-013
d = 0.8*h = 320.00
Nu = 6023.953
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
where:
Vs1 = 251327.412 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 500.00
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 425154.451
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 = 2.3685841E-020
θy = (My*Ls/3)/Eleff = 0.00363911 ((4.29),Biskinis Phd))
My = 1.2576E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 6023.953
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.2162520E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 260.4851
d = 357.00
ξy = 0.30059914
A = 0.02321789
B = 0.01307844
with pt = 0.00904198
pc = 0.00904198
pv = 0.00497199
N = 6023.953
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.0592201E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29926824
A = 0.02296007
B = 0.0129165

with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.22972747
lb = 300.00
ld = 1305.895
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 555.56
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

End Of Calculation of Shear Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (a)

Calculation No. 4

column C1, Floor 1

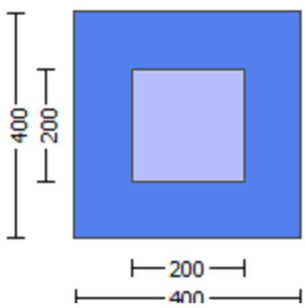
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

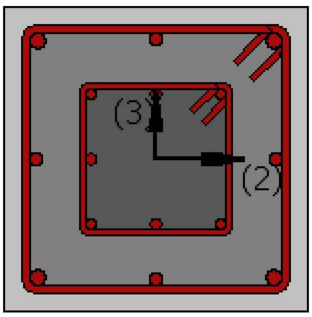
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (3)





Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjrs

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03547
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -1.0996693E-030
EDGE -B-
Shear Force, Vb = 1.0996693E-030
BOTH EDGES
Axial Force, F = -6026.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999

Calculation of Shear Capacity ratio , Ve/Vr = 0.21205453

Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 98315.01
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4747E+008
Mu1+ = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4747E+008
Mu2+ = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00

s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006

ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00

d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248

ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00

ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008

---

with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617

---

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

---

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45

fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)

--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 463630.789

Calculation of Shear Strength at edge 1, Vr1 = 463630.789
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.7987490E-012
Vu = 1.0996693E-030
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00

s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 463630.789
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.7987490E-012
Vu = 1.0996693E-030
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjrs

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00

New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03547
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 6.7333103E-047
EDGE -B-
Shear Force, Vb = -6.7333103E-047
BOTH EDGES
Axial Force, F = -6026.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999

Calculation of Shear Capacity ratio , Ve/Vr = 0.21205453
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 98315.01
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4747E+008
Mu1+ = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4747E+008
Mu2+ = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered

characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471

λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----

with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3

MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 463630.789

Calculation of Shear Strength at edge 1, Vr1 = 463630.789
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0970837E-012
Vu = 6.7333103E-047
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 463630.789
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0970837E-012

Vu = 6.7333103E-047
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rcjrs

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:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping

Stepwise Properties

Bending Moment, M = -2.0483E+007
Shear Force, V2 = -6825.705
Shear Force, V3 = -5.9576024E-013
Axial Force, F = -6023.953
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1291.195
-Compression: Aslc = 2001.195
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 829.3805
-Compression: Asl,com,jacket = 829.3805
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 461.8141
-Compression: Asl,com,core = 461.8141
-Middle: Asl,mid,core = 307.8761
Mean Diameter of Tension Reinforcement, DbL = 16.33333

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00728036
θu = θy + θp = 0.00728036

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00728036 ((4.29),Biskinis Phd))
My = 1.2576E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3000.884
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 6023.953
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.2162520E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 260.4851
d = 357.00
ξy = 0.30059914
A = 0.02321789
B = 0.01307844
with pt = 0.00442965
pc = 0.00904198
pv = 0.00497199
N = 6023.953
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.0592201E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29926824
A = 0.02296007
B = 0.0129165

with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.22972747
lb = 300.00
ld = 1305.895
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 555.56
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

- Calculation of θp -

From table 10-8: θp = 0.00
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
shear control ratio VyE/VCol0E = 0.21205453
d = d_external = 357.00
s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00442965
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00392699
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 400.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00050265
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 200.00
s2 = 250.00
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.
For the normalisation fs of jacket is used.
NUD = 6023.953
Ag = 160000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.02305595
b = 400.00
d = 357.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (a)

Calculation No. 5

column C1, Floor 1

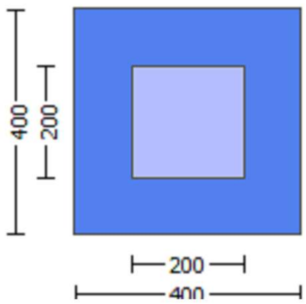
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

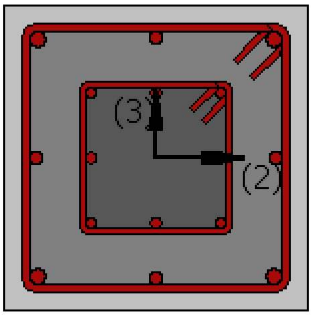
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)





Start Of Calculation of Shear Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rcjrs

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:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column

New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -2.0483E+007
Shear Force, Va = -6825.705
EDGE -B-
Bending Moment, Mb = -0.01979425
Shear Force, Vb = 6825.705
BOTH EDGES
Axial Force, F = -6023.953
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999
Mean Diameter of Tension Reinforcement, DbL,ten = 16.33333

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 411960.604
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 411960.604
VCol = 411960.604
knl = 1.00
displacement_ductility_demand = 0.24427809

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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.01979425
Vu = 6825.705
d = 0.8*h = 320.00
Nu = 6023.953
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
where:
Vs1 = 251327.412 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125

Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 500.00
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 425154.451
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 = 0.00017779
θy = (My*Ls/3)/EIeff = 0.00072782 ((4.29),Biskinis Phd))
My = 1.2576E+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 = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 6023.953
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.2162520E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 260.4851
d = 357.00
ξy = 0.30059914
A = 0.02321789
B = 0.01307844
with pt = 0.00904198
pc = 0.00904198
pv = 0.00497199
N = 6023.953
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.0592201E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29926824
A = 0.02296007
B = 0.0129165
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.22972747
lb = 300.00
ld = 1305.895
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.00

Mean strength value of all re-bars: fy = 555.56
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

End Of Calculation of Shear Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 6

column C1, Floor 1

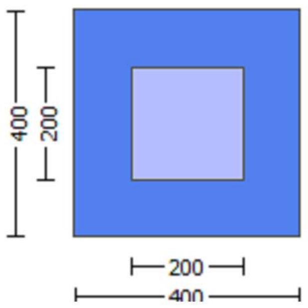
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

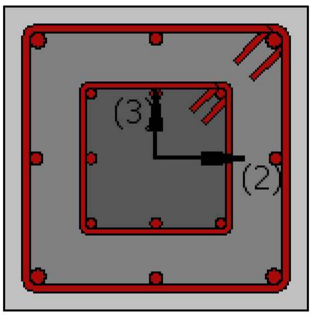
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (2)





Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjrs

Constant Properties

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

New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03547
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -1.0996693E-030
EDGE -B-
Shear Force, Vb = 1.0996693E-030
BOTH EDGES
Axial Force, F = -6026.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999

Calculation of Shear Capacity ratio , Ve/Vr = 0.21205453
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 98315.01
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4747E+008
Mu1+ = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4747E+008
Mu2+ = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796

No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683

and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00

ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 463630.789

Calculation of Shear Strength at edge 1, Vr1 = 463630.789
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.7987490E-012
Vu = 1.0996693E-030
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 463630.789
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.7987490E-012
Vu = 1.0996693E-030
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjrs

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
External Height, H = 400.00
External Width, W = 400.00

Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03547
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 6.7333103E-047
EDGE -B-
Shear Force, Vb = -6.7333103E-047
BOTH EDGES
Axial Force, F = -6026.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999

Calculation of Shear Capacity ratio , Ve/Vr = 0.21205453
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 98315.01
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4747E+008
Mu1+ = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4747E+008
Mu2+ = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404

The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198

εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00

n = 16.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991

εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617

ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397

ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288

ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 463630.789

Calculation of Shear Strength at edge 1, Vr1 = 463630.789
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0970837E-012
Vu = 6.7333103E-047
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 463630.789
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0970837E-012
Vu = 6.7333103E-047
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125

Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rcjrs

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:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping

Stepwise Properties

Bending Moment, M = 1.7638548E-010
Shear Force, V2 = 6825.705
Shear Force, V3 = 5.9576024E-013
Axial Force, F = -6023.953
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999

Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 829.3805
-Compression: Asl,com,jacket = 829.3805
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 461.8141
-Compression: Asl,com,core = 461.8141
-Middle: Asl,mid,core = 307.8761
Mean Diameter of Tension Reinforcement, DbL = 16.33333

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00363911
θu = θy + θp = 0.00363911

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00363911 ((4.29),Biskinis Phd))
My = 1.2576E+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 = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 6023.953
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.2162520E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 260.4851
d = 357.00
ξy = 0.30059914
A = 0.02321789
B = 0.01307844
with pt = 0.00442965
pc = 0.00904198
pv = 0.00497199
N = 6023.953
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.0592201E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29926824
A = 0.02296007
B = 0.0129165
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.22972747
lb = 300.00
ld = 1305.895
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.00

Mean strength value of all re-bars: fy = 555.56
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

- Calculation of θp -

From table 10-8: θp = 0.00
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
shear control ratio VyE/VCol0E = 0.21205453
d = d_external = 357.00
s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00442965
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00392699
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 400.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00050265
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 200.00
s2 = 250.00
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.
For the normalisation fs of jacket is used.
NUD = 6023.953
Ag = 160000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.02305595
b = 400.00
d = 357.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 7

column C1, Floor 1

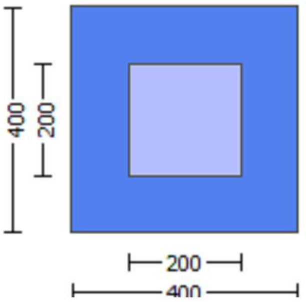
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

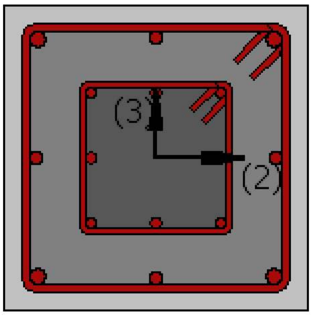
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)





Start Of Calculation of Shear Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcjrs

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:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member

Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = 1.6113210E-009
Shear Force, Va = -5.9576024E-013
EDGE -B-
Bending Moment, Mb = 1.7638548E-010
Shear Force, Vb = 5.9576024E-013
BOTH EDGES
Axial Force, F = -6023.953
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999
Mean Diameter of Tension Reinforcement, DbL,ten = 16.33333

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 411960.604
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 411960.604
VCol = 411960.604
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.7638548E-010
Vu = 5.9576024E-013
d = 0.8*h = 320.00
Nu = 6023.953
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
where:
Vs1 = 251327.412 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 500.00
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 425154.451
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 = 1.0935846E-020
θy = (My*Ls/3)/EIeff = 0.00363911 ((4.29),Biskinis Phd))
My = 1.2576E+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 = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 6023.953
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.2162520E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 260.4851
d = 357.00
ξy = 0.30059914
A = 0.02321789
B = 0.01307844
with pt = 0.00904198
pc = 0.00904198
pv = 0.00497199
N = 6023.953
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.0592201E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29926824
A = 0.02296007
B = 0.0129165
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.22972747
lb = 300.00
ld = 1305.895
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 555.56
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis

s = Max(s_external,s_internal) = 250.00
n = 16.00

End Of Calculation of Shear Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (b)

Calculation No. 8

column C1, Floor 1

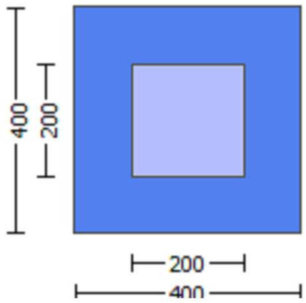
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

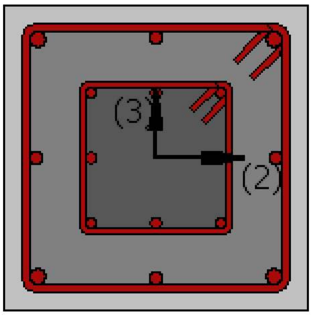
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (3)





Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjrs

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###

Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03547
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -1.0996693E-030
EDGE -B-
Shear Force, Vb = 1.0996693E-030
BOTH EDGES
Axial Force, F = -6026.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999

Calculation of Shear Capacity ratio , Ve/Vr = 0.21205453
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 98315.01
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4747E+008
Mu1+ = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4747E+008
Mu2+ = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----

with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3

MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00

fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052

Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699

Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198

εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00

v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991

εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00

cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 463630.789

Calculation of Shear Strength at edge 1, Vr1 = 463630.789
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.7987490E-012
Vu = 1.0996693E-030
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 463630.789
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.7987490E-012
Vu = 1.0996693E-030
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00

From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjrs

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03547
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 6.7333103E-047
EDGE -B-
Shear Force, Vb = -6.7333103E-047
BOTH EDGES
Axial Force, F = -6026.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999

Calculation of Shear Capacity ratio , Ve/Vr = 0.21205453
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 98315.01
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4747E+008
Mu1+ = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4747E+008
Mu2+ = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00

ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189

fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005

Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00

Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008

---

with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617

---

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

---

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00

s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006

ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 463630.789

Calculation of Shear Strength at edge 1, Vr1 = 463630.789
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0970837E-012
Vu = 6.7333103E-047
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 463630.789
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0970837E-012
Vu = 6.7333103E-047
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcjrs

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:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping

Stepwise Properties

Bending Moment, M = -0.01979425
Shear Force, V2 = 6825.705
Shear Force, V3 = 5.9576024E-013
Axial Force, F = -6023.953
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 829.3805
-Compression: Asl,com,jacket = 829.3805
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 461.8141
-Compression: Asl,com,core = 461.8141
-Middle: Asl,mid,core = 307.8761
Mean Diameter of Tension Reinforcement, DbL = 16.33333

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00072782
θu = θy + θp = 0.00072782

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00072782 ((4.29),Biskinis Phd))
My = 1.2576E+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 = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 6023.953
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.2162520E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 260.4851
d = 357.00
ξy = 0.30059914
A = 0.02321789
B = 0.01307844
with pt = 0.00442965
pc = 0.00904198
pv = 0.00497199
N = 6023.953
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.0592201E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29926824
A = 0.02296007
B = 0.0129165
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.22972747
lb = 300.00
ld = 1305.895
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 555.56
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis

s = Max(s_external,s_internal) = 250.00
n = 16.00

- Calculation of θp -

From table 10-8: θp = 0.00
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
shear control ratio VyE/VCol0E = 0.21205453
d = d_external = 357.00
s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00442965
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00392699
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 400.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00050265
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 200.00
s2 = 250.00
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.
For the normalisation fs of jacket is used.
NUD = 6023.953
Ag = 160000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.02305595
b = 400.00
d = 357.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (b)

Calculation No. 9

column C1, Floor 1

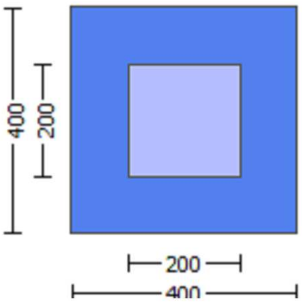
Limit State: Life Safety (data interpolation between analysis steps 2 and 3)

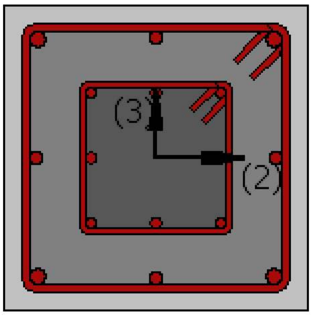
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)





Start Of Calculation of Shear Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcjrs

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:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
###
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -2.4462E+007
Shear Force, Va = -8151.474

EDGE -B-
Bending Moment, Mb = 224.2544
Shear Force, Vb = 8151.474
BOTH EDGES
Axial Force, F = -6025.178
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1291.195
-Compression: Aslc = 2001.195
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999
Mean Diameter of Tension Reinforcement, DbL,ten = 16.33333

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 331644.13
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 331644.13
VCol = 331644.13
knl = 1.00
displacement_ductility_demand = 0.05572044

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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
Mu = 2.4462E+007
Vu = 8151.474
d = 0.8*h = 320.00
Nu = 6025.178
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
where:
Vs1 = 251327.412 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 500.00
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 425154.451
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 = 0.00040567
θy = (My*Ls/3)/EIeff = 0.00728046 ((4.29),Biskinis Phd))
My = 1.2577E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3000.924
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7280E+013

factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 6025.178
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.2162547E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 260.4851
d = 357.00
ξy = 0.3005995
A = 0.02321793
B = 0.01307848
with pt = 0.00904198
pc = 0.00904198
pv = 0.00497199
N = 6025.178
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.0592195E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29926833
A = 0.02296005
B = 0.0129165
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.22972747
lb = 300.00
ld = 1305.895
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 555.56
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

End Of Calculation of Shear Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 10

column C1, Floor 1

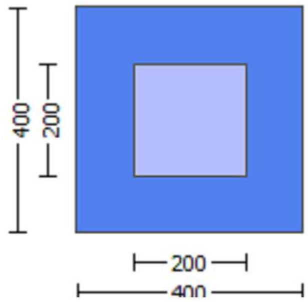
Limit State: Life Safety (data interpolation between analysis steps 2 and 3)

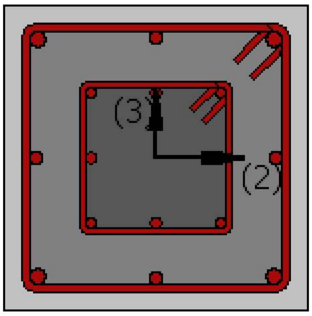
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (2)





Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjrs

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00

Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03547
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -1.0996693E-030
EDGE -B-
Shear Force, Vb = 1.0996693E-030
BOTH EDGES
Axial Force, F = -6026.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999

Calculation of Shear Capacity ratio , Ve/Vr = 0.21205453
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 98315.01
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4747E+008
Mu1+ = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4747E+008
Mu2+ = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404

ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796

No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683

and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00

ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 463630.789

Calculation of Shear Strength at edge 1, Vr1 = 463630.789
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.7987490E-012
Vu = 1.0996693E-030
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 463630.789
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.7987490E-012
Vu = 1.0996693E-030
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00

Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjrs

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03547
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 6.7333103E-047
EDGE -B-
Shear Force, Vb = -6.7333103E-047

BOTH EDGES
Axial Force, F = -6026.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999

Calculation of Shear Capacity ratio , Ve/Vr = 0.21205453
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 98315.01
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4747E+008
Mu1+ = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4747E+008
Mu2+ = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531

No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404

The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198

εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00

n = 16.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991

εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617

ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397

ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 463630.789

Calculation of Shear Strength at edge 1, Vr1 = 463630.789
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0970837E-012
Vu = 6.7333103E-047
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914

where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 463630.789
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0970837E-012
Vu = 6.7333103E-047
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (a)

Section Type: rcjrs

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:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping

Stepwise Properties

Bending Moment, M = 1.9202516E-009
Shear Force, V2 = -8151.474
Shear Force, V3 = -7.0895948E-013
Axial Force, F = -6025.178
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1291.195
-Compression: Aslc = 2001.195
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 829.3805
-Compression: Asl,com,jacket = 829.3805
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 461.8141
-Compression: Asl,com,core = 461.8141
-Middle: Asl,mid,core = 307.8761
Mean Diameter of Tension Reinforcement, DbL = 16.33333

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.03196698
θu = θy + θp = 0.03196698

- Calculation of θy -

θy = (My*Ls/3)/Eleff = 0.00363911 ((4.29),Biskinis Phd))
My = 1.2577E+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 = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 6025.178
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.2162547E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 260.4851
d = 357.00
ξy = 0.3005995
A = 0.02321793
B = 0.01307848
with pt = 0.00442965
pc = 0.00904198
pv = 0.00497199
N = 6025.178
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.0592195E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29926833
A = 0.02296005
B = 0.0129165
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.22972747
lb = 300.00
ld = 1305.895
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 555.56
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

- Calculation of θp -

From table 10-8: θp = 0.02832787
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
shear control ratio VyE/VCol0E = 0.21205453
d = d_external = 357.00

s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00442965
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00392699
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 400.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00050265
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 200.00
s2 = 250.00
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.
For the normalisation fs of jacket is used.
NUD = 6025.178
Ag = 160000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.02305595
b = 400.00
d = 357.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 11

column C1, Floor 1

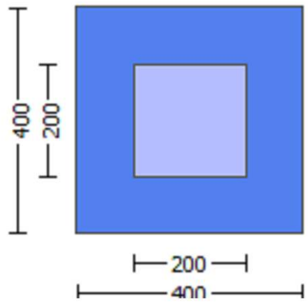
Limit State: Life Safety (data interpolation between analysis steps 2 and 3)

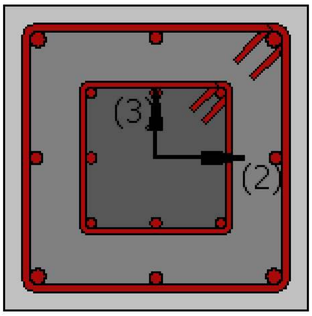
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)





Start Of Calculation of Shear Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rcjrs

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:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = 1.9202516E-009
Shear Force, Va = -7.0895948E-013

EDGE -B-
Bending Moment, Mb = 2.0714171E-010
Shear Force, Vb = 7.0895948E-013
BOTH EDGES
Axial Force, F = -6025.178
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1291.195
-Compression: Aslc = 2001.195
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999
Mean Diameter of Tension Reinforcement, DbL,ten = 16.33333

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 411960.847
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 411960.847
VCol = 411960.847
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.9202516E-009
Vu = 7.0895948E-013
d = 0.8*h = 320.00
Nu = 6025.178
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
where:
Vs1 = 251327.412 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 500.00
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 425154.451
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 = 2.8606335E-020
θy = (My*Ls/3)/EIeff = 0.00363911 ((4.29),Biskinis Phd))
My = 1.2577E+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 = 1.7280E+013

factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 6025.178
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.2162547E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 260.4851
d = 357.00
ξy = 0.3005995
A = 0.02321793
B = 0.01307848
with pt = 0.00904198
pc = 0.00904198
pv = 0.00497199
N = 6025.178
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.0592195E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29926833
A = 0.02296005
B = 0.0129165
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.22972747
lb = 300.00
ld = 1305.895
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 555.56
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

End Of Calculation of Shear Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (a)

Calculation No. 12

column C1, Floor 1

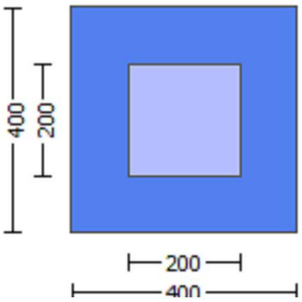
Limit State: Life Safety (data interpolation between analysis steps 2 and 3)

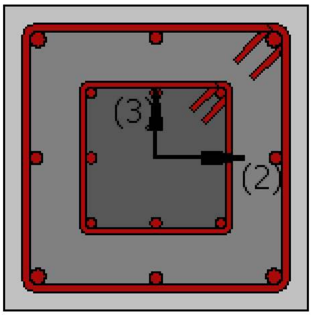
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (3)





Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjrs

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00

Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03547
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -1.0996693E-030
EDGE -B-
Shear Force, Vb = 1.0996693E-030
BOTH EDGES
Axial Force, F = -6026.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999

Calculation of Shear Capacity ratio , Ve/Vr = 0.21205453
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 98315.01
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4747E+008
Mu1+ = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4747E+008
Mu2+ = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404

ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796

No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683

and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00

ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 463630.789

Calculation of Shear Strength at edge 1, Vr1 = 463630.789
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.7987490E-012
Vu = 1.0996693E-030
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 463630.789
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.7987490E-012
Vu = 1.0996693E-030
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00

Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjrs

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03547
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 6.7333103E-047
EDGE -B-
Shear Force, Vb = -6.7333103E-047

BOTH EDGES
Axial Force, F = -6026.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999

Calculation of Shear Capacity ratio , Ve/Vr = 0.21205453
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 98315.01
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4747E+008
Mu1+ = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4747E+008
Mu2+ = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531

No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

$\varepsilon y1, \varepsilon sh1, ft1, fy1$, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
$\omega 1$ = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
$\omega 2$ = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
$\omega 1$ = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
$\omega 2$ = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
$\varphi u = \varphi su$ (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu^* = shear_factor * Max($\varepsilon cu, \varepsilon cc$) = 0.00951404

The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198

εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00

n = 16.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991

εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617

ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397

ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 463630.789

Calculation of Shear Strength at edge 1, Vr1 = 463630.789
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0970837E-012
Vu = 6.7333103E-047
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914

where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 463630.789
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0970837E-012
Vu = 6.7333103E-047
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (a)

Section Type: rcjrs

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:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping

Stepwise Properties

Bending Moment, M = -2.4462E+007
Shear Force, V2 = -8151.474
Shear Force, V3 = -7.0895948E-013
Axial Force, F = -6025.178
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1291.195
-Compression: Aslc = 2001.195
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 829.3805
-Compression: Asl,com,jacket = 829.3805
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 461.8141
-Compression: Asl,com,core = 461.8141
-Middle: Asl,mid,core = 307.8761
Mean Diameter of Tension Reinforcement, DbL = 16.33333

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.03560834
θu = θy + θp = 0.03560834

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00728046 ((4.29),Biskinis Phd))
My = 1.2577E+008

Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3000.924
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 6025.178
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.2162547E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 260.4851
d = 357.00
ξy = 0.3005995
A = 0.02321793
B = 0.01307848
with pt = 0.00442965
pc = 0.00904198
pv = 0.00497199
N = 6025.178
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.0592195E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29926833
A = 0.02296005
B = 0.0129165
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.22972747
lb = 300.00
ld = 1305.895
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 555.56
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

- Calculation of θp -

From table 10-8: θp = 0.02832787
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
shear control ratio VyE/VCol0E = 0.21205453
d = d_external = 357.00

s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00442965
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00392699
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 400.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00050265
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 200.00
s2 = 250.00
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.
For the normalisation fs of jacket is used.
NUD = 6025.178
Ag = 160000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.02305595
b = 400.00
d = 357.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (a)

Calculation No. 13

column C1, Floor 1

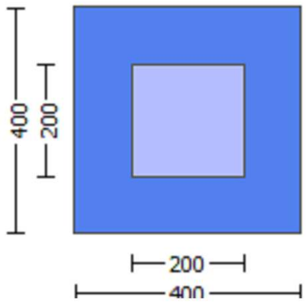
Limit State: Life Safety (data interpolation between analysis steps 2 and 3)

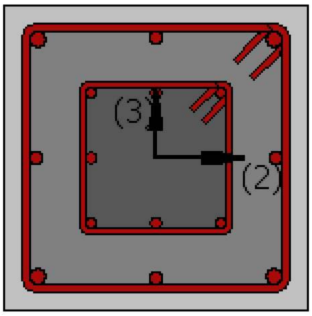
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)





Start Of Calculation of Shear Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rcjrs

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:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
###
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -2.4462E+007
Shear Force, Va = -8151.474

EDGE -B-
Bending Moment, Mb = 224.2544
Shear Force, Vb = 8151.474
BOTH EDGES
Axial Force, F = -6025.178
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999
Mean Diameter of Tension Reinforcement, DbL,ten = 16.33333

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 411960.847
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 411960.847
VCol = 411960.847
knl = 1.00
displacement_ductility_demand = 0.29173319

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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 224.2544
Vu = 8151.474
d = 0.8*h = 320.00
Nu = 6025.178
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
where:
Vs1 = 251327.412 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 500.00
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 425154.451
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 = 0.00021233
θy = (My*Ls/3)/EIeff = 0.00072782 ((4.29),Biskinis Phd))
My = 1.2577E+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 = 1.7280E+013

factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 6025.178
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.2162547E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 260.4851
d = 357.00
ξy = 0.3005995
A = 0.02321793
B = 0.01307848
with pt = 0.00904198
pc = 0.00904198
pv = 0.00497199
N = 6025.178
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.0592195E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29926833
A = 0.02296005
B = 0.0129165
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.22972747
lb = 300.00
ld = 1305.895
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 555.56
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

End Of Calculation of Shear Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 14

column C1, Floor 1

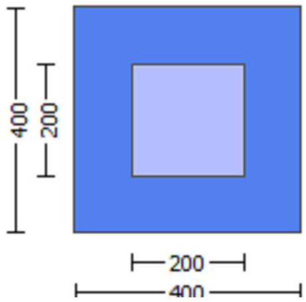
Limit State: Life Safety (data interpolation between analysis steps 2 and 3)

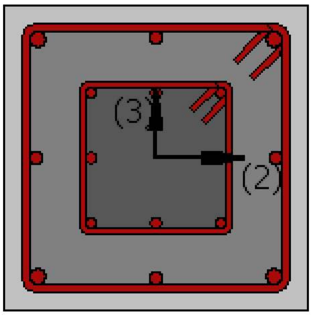
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (2)





Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjrs

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00

Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03547
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -1.0996693E-030
EDGE -B-
Shear Force, Vb = 1.0996693E-030
BOTH EDGES
Axial Force, F = -6026.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999

Calculation of Shear Capacity ratio , Ve/Vr = 0.21205453
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 98315.01
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4747E+008
Mu1+ = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4747E+008
Mu2+ = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404

ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796

No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683

and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00

ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 463630.789

Calculation of Shear Strength at edge 1, Vr1 = 463630.789
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.7987490E-012
Vu = 1.0996693E-030
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 463630.789
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.7987490E-012
Vu = 1.0996693E-030
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00

Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjrs

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03547
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 6.7333103E-047
EDGE -B-
Shear Force, Vb = -6.7333103E-047

BOTH EDGES
Axial Force, F = -6026.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999

Calculation of Shear Capacity ratio , Ve/Vr = 0.21205453
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 98315.01
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4747E+008
Mu1+ = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4747E+008
Mu2+ = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531

No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404

The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198

εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00

n = 16.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991

εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617

ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397

ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 463630.789

Calculation of Shear Strength at edge 1, Vr1 = 463630.789
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0970837E-012
Vu = 6.7333103E-047
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914

where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 463630.789
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0970837E-012
Vu = 6.7333103E-047
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (b)

Section Type: rcjrs

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:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping

Stepwise Properties

Bending Moment, M = 2.0714171E-010
Shear Force, V2 = 8151.474
Shear Force, V3 = 7.0895948E-013
Axial Force, F = -6025.178
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 829.3805
-Compression: Asl,com,jacket = 829.3805
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 461.8141
-Compression: Asl,com,core = 461.8141
-Middle: Asl,mid,core = 307.8761
Mean Diameter of Tension Reinforcement, DbL = 16.33333

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.03196698
θu = θy + θp = 0.03196698

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00363911 ((4.29),Biskinis Phd))
My = 1.2577E+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 = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 6025.178
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.2162547E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 260.4851
d = 357.00
ξy = 0.3005995
A = 0.02321793
B = 0.01307848
with pt = 0.00442965
pc = 0.00904198
pv = 0.00497199
N = 6025.178
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.0592195E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29926833
A = 0.02296005
B = 0.0129165
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.22972747
lb = 300.00
ld = 1305.895
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 555.56
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

- Calculation of θp -

From table 10-8: θp = 0.02832787
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
shear control ratio VyE/VCol0E = 0.21205453
d = d_external = 357.00

s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00442965
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00392699
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 400.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00050265
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 200.00
s2 = 250.00
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.
For the normalisation fs of jacket is used.
NUD = 6025.178
Ag = 160000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.02305595
b = 400.00
d = 357.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 15

column C1, Floor 1

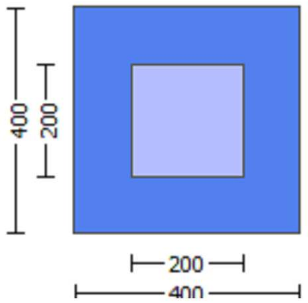
Limit State: Life Safety (data interpolation between analysis steps 2 and 3)

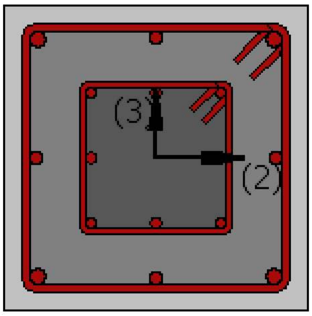
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)





Start Of Calculation of Shear Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcjrs

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:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = 1.9202516E-009
Shear Force, Va = -7.0895948E-013

EDGE -B-
Bending Moment, Mb = 2.0714171E-010
Shear Force, Vb = 7.0895948E-013
BOTH EDGES
Axial Force, F = -6025.178
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999
Mean Diameter of Tension Reinforcement, DbL,ten = 16.33333

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 411960.847
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 411960.847
VCol = 411960.847
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 2.0714171E-010
Vu = 7.0895948E-013
d = 0.8*h = 320.00
Nu = 6025.178
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
where:
Vs1 = 251327.412 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 500.00
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 425154.451
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 = 1.3038466E-020
θy = (My*Ls/3)/EIeff = 0.00363911 ((4.29),Biskinis Phd))
My = 1.2577E+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 = 1.7280E+013

factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 6025.178
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.2162547E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 260.4851
d = 357.00
ξy = 0.3005995
A = 0.02321793
B = 0.01307848
with pt = 0.00904198
pc = 0.00904198
pv = 0.00497199
N = 6025.178
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.0592195E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29926833
A = 0.02296005
B = 0.0129165
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.22972747
lb = 300.00
ld = 1305.895
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 555.56
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

End Of Calculation of Shear Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (b)

Calculation No. 16

column C1, Floor 1

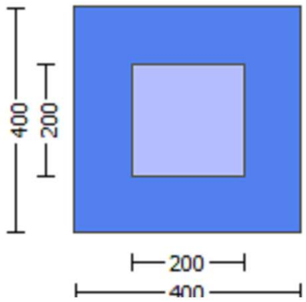
Limit State: Life Safety (data interpolation between analysis steps 2 and 3)

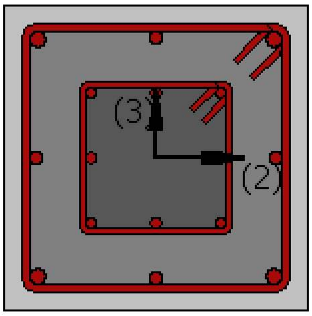
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (3)





Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjrs

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00

Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03547
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -1.0996693E-030
EDGE -B-
Shear Force, Vb = 1.0996693E-030
BOTH EDGES
Axial Force, F = -6026.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999

Calculation of Shear Capacity ratio , Ve/Vr = 0.21205453
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 98315.01
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4747E+008
Mu1+ = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4747E+008
Mu2+ = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404

ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796

No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683

and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00

ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617

---

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

---

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 463630.789

Calculation of Shear Strength at edge 1, Vr1 = 463630.789
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.7987490E-012
Vu = 1.0996693E-030
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 463630.789
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.7987490E-012
Vu = 1.0996693E-030
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00

Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjrs

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03547
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 6.7333103E-047
EDGE -B-
Shear Force, Vb = -6.7333103E-047

BOTH EDGES
Axial Force, F = -6026.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999

Calculation of Shear Capacity ratio , Ve/Vr = 0.21205453
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 98315.01
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.4747E+008
Mu1+ = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.4747E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.4747E+008
Mu2+ = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.4747E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531

No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404

The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198

εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00

n = 16.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991

εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.1814054E-005
Mu = 1.4747E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.0012789
N = 6026.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.00951404
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00951404
ωwe (5.4c) = 0.02260544
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617

ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00235471
λc = confinement factor = 1.03547
εy1 = 0.00101015
εsh1 = 0.00323248
ft1 = 336.7189
fy1 = 280.5991
εsu1 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from 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,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 280.5991
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00101015
εsh2 = 0.00323248
ft2 = 336.7189
fy2 = 280.5991
εsu2 = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.18378198
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from 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,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 280.5991
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00101015
εshv = 0.00323248
ftv = 336.7189
fyv = 280.5991
εsuv = 0.00323248
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.18378198
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from 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,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 280.5991
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07688397

ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07688397
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04227683
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.17054
εcc (5A.5, TBDY) = 0.00235471
λc = confinement factor = 1.03547
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.09875006
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09875006
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05430052
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.23357771
Mu = MRc (4.14) = 1.4747E+008
φu = φsu (4.1) = 1.1814054E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.18378198
lb = 300.00
ld = 1632.369
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 694.45
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 463630.789

Calculation of Shear Strength at edge 1, Vr1 = 463630.789
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0970837E-012
Vu = 6.7333103E-047
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914

where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 463630.789
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 463630.789
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)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0970837E-012
Vu = 6.7333103E-047
d = 0.8*h = 320.00
Nu = 6026.684
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (b)

Section Type: rcjrs

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:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping

Stepwise Properties

Bending Moment, M = 224.2544
Shear Force, V2 = 8151.474
Shear Force, V3 = 7.0895948E-013
Axial Force, F = -6025.178
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1291.195
-Compression: Asl,com = 1291.195
-Middle: Asl,mid = 709.9999
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 829.3805
-Compression: Asl,com,jacket = 829.3805
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 461.8141
-Compression: Asl,com,core = 461.8141
-Middle: Asl,mid,core = 307.8761
Mean Diameter of Tension Reinforcement, DbL = 16.33333

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.0290557
θu = θy + θp = 0.0290557

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00072782 ((4.29),Biskinis Phd))
My = 1.2577E+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 = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 6025.178
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.2162547E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 260.4851
d = 357.00
ξy = 0.3005995
A = 0.02321793
B = 0.01307848
with pt = 0.00442965
pc = 0.00904198
pv = 0.00497199
N = 6025.178
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.0592195E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.29926833
A = 0.02296005
B = 0.0129165
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.22972747
lb = 300.00
ld = 1305.895
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 16.00
Mean strength value of all re-bars: fy = 555.56
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 2.57611
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 16.00

- Calculation of θp -

From table 10-8: θp = 0.02832787
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
shear control ratio VyE/VCol0E = 0.21205453
d = d_external = 357.00

s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00442965
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00392699
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 400.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00050265
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 200.00
s2 = 250.00
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.
For the normalisation fs of jacket is used.
NUD = 6025.178
Ag = 160000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.02305595
b = 400.00
d = 357.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (b)
