Detailed Member Calculations

Units: N&mm

Regulation: ASCE 41-17

Calculation No. 1

column C1, Floor 1

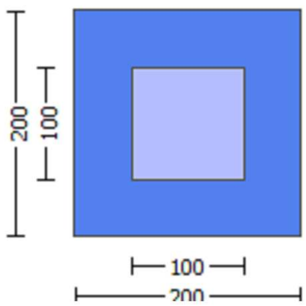
Limit State: Operational Level (data interpolation between analysis steps 50 and 51)

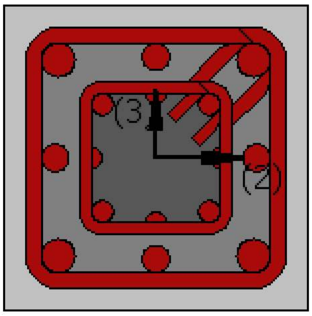
Analysis: Uniform +X

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
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
Adequate Lap Length (lo/lou,min = lb/ld >=1)
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -2.2562E+008
Shear Force, Va = -2372.544
EDGE -B-
Bending Moment, Mb = -573480.362
Shear Force, Vb = 2372.544
BOTH EDGES
Axial Force, F = -952838.426
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1476.549
-Compression: Aslc = 2293.363
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141
Mean Diameter of Tension Reinforcement, DbL,ten = 17.33333

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 171057.547
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 171057.547
VCol = 171057.547
knl = 1.00
displacement_ductility_demand = 1.01651

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 = 2.2562E+008
Vu = 2372.544
d = 0.8*h = 160.00
Nu = 952838.426
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 125663.706
where:
Vs1 = 125663.706 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 500.00
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 106288.613
bw = 200.00

----
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 = 0.07658823
θy = (My*Ls/3)/Eleff = 0.07534453 ((4.29),Biskinis Phd))
My = 9.4932E+007
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 6000.00
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 2.5199E+012
factor = 0.70
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 952838.426
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5999E+012

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0448288E-005
with fy = 555.56
d = 166.00
ξy = 0.58629312
A = 0.16521104
B = 0.12006404
with pt = 0.04447435
pc = 0.04447435
pv = 0.02460283
N = 952838.426
b = 200.00
δ'' = 0.20481928
Φy_comp = 1.8654349E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.71046623

A = 0.04832572
B = 0.06840454
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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

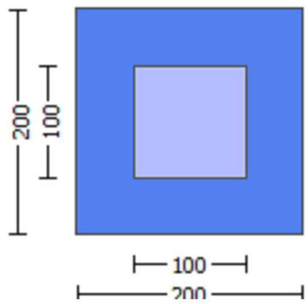
Limit State: Operational Level (data interpolation between analysis steps 50 and 51)

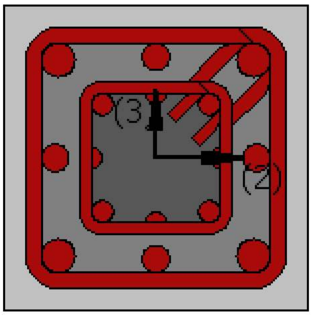
Analysis: Uniform +X

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.02878
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
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -1.1598602E-029
EDGE -B-
Shear Force, Vb = 1.1598602E-029
BOTH EDGES
Axial Force, F = -954435.753
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141

Calculation of Shear Capacity ratio , Ve/Vr = 0.43225659
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 113270.442
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.6991E+008
Mu1+ = 1.6991E+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- = 1.6991E+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-) = 1.6991E+008
Mu2+ = 1.6991E+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- = 1.6991E+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 = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216

MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025

εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.

--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208

bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->

v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 262044.453

Calculation of Shear Strength at edge 1, Vr1 = 262044.453
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 3.6564195E-010
Vu = 1.1598602E-029
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 262044.453
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 3.6564195E-010
Vu = 1.1598602E-029
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00

Mean Confinement Factor overall section = 1.02878
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
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 7.1018611E-046
EDGE -B-
Shear Force, Vb = -7.1018611E-046
BOTH EDGES
Axial Force, F = -954435.753
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141

Calculation of Shear Capacity ratio , Ve/Vr = 0.43225659
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 113270.442
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.6991E+008
Mu1+ = 1.6991E+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- = 1.6991E+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-) = 1.6991E+008
Mu2+ = 1.6991E+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- = 1.6991E+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 = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521

ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered

characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->

v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00

h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983

εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00

d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34

fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel

```
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) =  8.6451905E-005
Mu = MRc
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
----------------------------------------------------------------------------
----------------------------------------------------------------------------
----------------------------------------------------------------------------
Calculation of Mu2-
----------------------------------------------------------------------------

----------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----------------------------------------------------------------------------
with full section properties:
  b = 200.00
  d = 166.00
  d' = 34.00
  v = 0.87115348
    N = 954435.753
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01061002
    ωwe (5.4c) = 0.03159521
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
        ase1 = 0.15755208
          bo_1 = 160.00
          ho_1 = 160.00
          Σbi2_1 = 102400.00
      ase2 = Max(ase1,ase2) = 0.15755208
          bo_2 = 92.00
          ho_2 = 92.00
          Σbi2_2 = 33856.00
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
    --------------------------------------------------------------------
      psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
        ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
          Ash1 = Astir_1*ns_1 = 157.0796
            No stirups, ns_1 = 2.00
          h1 = 200.00
        ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
          Ash2 = Astir_2*ns_2 = 100.531
            No stirups, ns_2 = 2.00
          h2 = 100.00
```

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 262044.453

Calculation of Shear Strength at edge 1, Vr1 = 262044.453
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 2.9879866E-010
Vu = 7.1018611E-046
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 262044.453
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 2.9879866E-010
Vu = 7.1018611E-046
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00

Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
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
Adequate Lap Length (lb/ld>=1)
No FRP Wrapping

Stepwise Properties

Bending Moment, M = -3.7448736E-006
Shear Force, V2 = -2372.544
Shear Force, V3 = -4.1216227E-010
Axial Force, F = -952838.426
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1476.549
-Compression: Aslc = 2293.363
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 1014.734

-Compression: Asl,com,jacket = 1014.734
-Middle: Asl,mid,jacket = 508.938
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 = 17.33333

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.01988947
θu = θy + θp = 0.01988947

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.01883613 ((4.29),Biskinis Phd))
My = 9.4932E+007
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 = 2.5199E+012
factor = 0.70
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 952838.426
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5999E+012

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0448288E-005
with fy = 555.56
d = 166.00
ξy = 0.58629312
A = 0.16521104
B = 0.12006404
with pt = 0.0095295
pc = 0.04447435
pv = 0.02460283
N = 952838.426
b = 200.00
δ'' = 0.20481928
Φy_comp = 1.8654349E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.71046623
A = 0.04832572
B = 0.06840454
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

- Calculation of θp -

From table 10-8: θp = 0.00105334
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.43225659
d = d_external = 166.00

s = s_external = 150.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.0095295
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00785398
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 200.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00167552
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 100.00
s2 = 150.00
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 = 952838.426
Ag = 40000.00
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) = 0.11355154
b = 200.00
d = 166.00
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

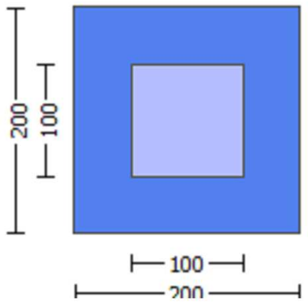
Limit State: Operational Level (data interpolation between analysis steps 50 and 51)

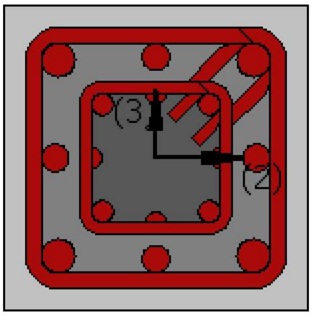
Analysis: Uniform +X

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
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
Adequate Lap Length (lo/lou,min = lb/ld >=1)
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -3.7448736E-006
Shear Force, Va = -4.1216227E-010

EDGE -B-
Bending Moment, Mb = 5.8770792E-007
Shear Force, Vb = 4.1216227E-010
BOTH EDGES
Axial Force, F = -952838.426
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1476.549
-Compression: Aslc = 2293.363
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141
Mean Diameter of Tension Reinforcement, DbL,ten = 17.33333

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 235826.482
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 235826.482
VCol = 235826.482
knl = 1.00
displacement_ductility_demand = 8.1601392E-014

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 = 3.7448736E-006
Vu = 4.1216227E-010
d = 0.8*h = 160.00
Nu = 952838.426
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 125663.706
where:
Vs1 = 125663.706 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 500.00
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 106288.613
bw = 200.00

----
displacement_ductility_demand is calculated as θ/θy

- Calculation of θ/θy for END A -
for rotation axis 2 and integ. section (a)

From analysis, chord rotation θ = 1.5355735E-015
θy = (My*Ls/3)/EIeff = 0.01883613 ((4.29),Biskinis Phd))
My = 9.4932E+007
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 = 2.5199E+012

factor = 0.70
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 952838.426
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5999E+012

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0448288E-005
with fy = 555.56
d = 166.00
ξy = 0.58629312
A = 0.16521104
B = 0.12006404
with pt = 0.04447435
pc = 0.04447435
pv = 0.02460283
N = 952838.426
b = 200.00
δ'' = 0.20481928
Φy_comp = 1.8654349E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.71046623
A = 0.04832572
B = 0.06840454
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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

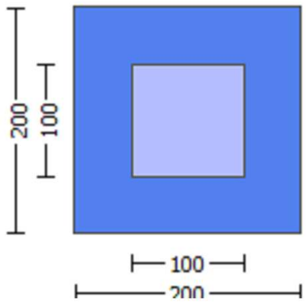
Limit State: Operational Level (data interpolation between analysis steps 50 and 51)

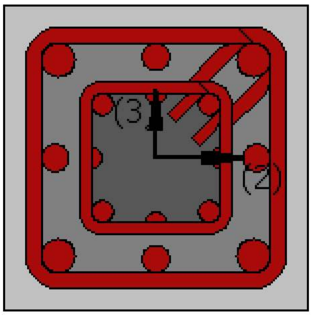
Analysis: Uniform +X

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.02878
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
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -1.1598602E-029
EDGE -B-
Shear Force, Vb = 1.1598602E-029
BOTH EDGES

Axial Force, F = -954435.753
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141

Calculation of Shear Capacity ratio , Ve/Vr = 0.43225659
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 113270.442
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.6991E+008
Mu1+ = 1.6991E+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- = 1.6991E+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-) = 1.6991E+008
Mu2+ = 1.6991E+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- = 1.6991E+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 = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00

h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00

εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->

ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878

εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->

Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
   - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
   - N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
   - σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 262044.453

Calculation of Shear Strength at edge 1, Vr1 = 262044.453
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 262044.453
   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 = 3.6564195E-010
      Vu = 1.1598602E-029
    d = 0.8*h = 160.00
    Nu = 954435.753
    Ag = 40000.00
    From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457

where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 262044.453
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 3.6564195E-010
Vu = 1.1598602E-029
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.02878
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
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 7.1018611E-046
EDGE -B-
Shear Force, Vb = -7.1018611E-046
BOTH EDGES
Axial Force, F = -954435.753
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141

Calculation of Shear Capacity ratio , Ve/Vr = 0.43225659
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 113270.442
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.6991E+008
Mu1+ = 1.6991E+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- = 1.6991E+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-) = 1.6991E+008
Mu2+ = 1.6991E+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- = 1.6991E+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 = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00

From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->

v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
   - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
   - N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
   - σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
   b = 200.00
   d = 166.00
   d' = 34.00
   v = 0.87115348
      N = 954435.753
   fc = 33.00
   εco (5A.5, TBDY) = 0.002
   Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: εcu = 0.01061002

ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone

```
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) =  8.6451905E-005
Mu = MRc
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
----------------------------------------------------------------------------
----------------------------------------------------------------------------
----------------------------------------------------------------------------
Calculation of Mu2+
----------------------------------------------------------------------------

----------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----------------------------------------------------------------------------
with full section properties:
   b = 200.00
   d = 166.00
   d' = 34.00
   v = 0.87115348
      N = 954435.753
   fc = 33.00
   εco (5A.5, TBDY) = 0.002
   Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: εcu = 0.01061002
      ωwe (5.4c) = 0.03159521
         ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
            ase1 = 0.15755208
               bo_1 = 160.00
               ho_1 = 160.00
               Σbi2_1 = 102400.00
         ase2 = Max(ase1,ase2) = 0.15755208
               bo_2 = 92.00
               ho_2 = 92.00
               Σbi2_2 = 33856.00
         psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
      -------------------------------------------------------------------
         psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
            ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
               Ash1 = Astir_1*ns_1 = 157.0796
                  No stirups, ns_1 = 2.00
               h1 = 200.00
            ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
               Ash2 = Astir_2*ns_2 = 100.531
                  No stirups, ns_2 = 2.00
               h2 = 100.00
      -------------------------------------------------------------------
         psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
            ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
               Ash1 = Astir_1*ns_1 = 157.0796
                  No stirups, ns_1 = 2.00
               h1 = 200.00
            ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
               Ash2 = Astir_2*ns_2 = 100.531
```

No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00

fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00

d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008

ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->

Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 262044.453

Calculation of Shear Strength at edge 1, Vr1 = 262044.453
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 2.9879866E-010
Vu = 7.1018611E-046
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 262044.453
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 2.9879866E-010
Vu = 7.1018611E-046
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
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
Adequate Lap Length (lb/ld>=1)
No FRP Wrapping

Stepwise Properties

Bending Moment, M = -2.2562E+008
Shear Force, V2 = -2372.544
Shear Force, V3 = -4.1216227E-010
Axial Force, F = -952838.426
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1476.549
-Compression: Aslc = 2293.363
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 1014.734
-Compression: Asl,com,jacket = 1014.734
-Middle: Asl,mid,jacket = 508.938
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 = 17.33333

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.07639787
θu = θy + θp = 0.07639787

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.07534453 ((4.29),Biskinis Phd))
My = 9.4932E+007
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 6000.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.5199E+012
factor = 0.70
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 952838.426
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5999E+012

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0448288E-005
with fy = 555.56
d = 166.00

ξy = 0.58629312
A = 0.16521104
B = 0.12006404
with pt = 0.0095295
pc = 0.04447435
pv = 0.02460283
N = 952838.426
b = 200.00
δ" = 0.20481928
Φy_comp = 1.8654349E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.71046623
A = 0.04832572
B = 0.06840454
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

- Calculation of θp -

From table 10-8: θp = 0.00105334
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.43225659
d = d_external = 166.00
s = s_external = 150.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.0095295
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00785398
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 200.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00167552
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 100.00
s2 = 150.00
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 = 952838.426
Ag = 40000.00
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) = 0.11355154
b = 200.00
d = 166.00
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

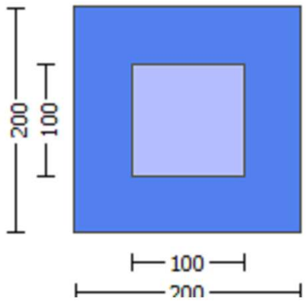
Limit State: Operational Level (data interpolation between analysis steps 50 and 51)

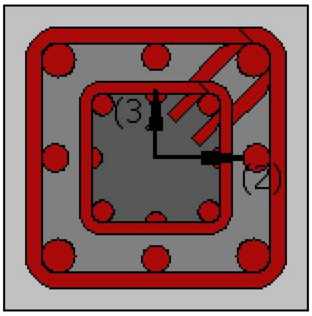
Analysis: Uniform +X

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
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
Adequate Lap Length (lo/lou,min = lb/ld >=1)
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -2.2562E+008
Shear Force, Va = -2372.544
EDGE -B-
Bending Moment, Mb = -573480.362
Shear Force, Vb = 2372.544
BOTH EDGES
Axial Force, F = -952838.426
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141
Mean Diameter of Tension Reinforcement, DbL,ten = 17.33333

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 165078.538
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 165078.538
VCol = 235826.482
knl = 0.70
displacement_ductility_demand = 8.27565

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 = 573480.362
Vu = 2372.544
d = 0.8*h = 160.00
Nu = 952838.426
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 125663.706
where:
Vs1 = 125663.706 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965

fy = 500.00
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 106288.613
bw = 200.00

----
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 = 0.03117626
θy = (My*Ls/3)/EIeff = 0.00376723 ((4.29),Biskinis Phd))
My = 9.4932E+007
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 = 2.5199E+012
factor = 0.70
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 952838.426
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5999E+012

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0448288E-005
with fy = 555.56
d = 166.00
ξy = 0.58629312
A = 0.16521104
B = 0.12006404
with pt = 0.04447435
pc = 0.04447435
pv = 0.02460283
N = 952838.426
b = 200.00
δ'' = 0.20481928
Φy_comp = 1.8654349E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.71046623
A = 0.04832572
B = 0.06840454
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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

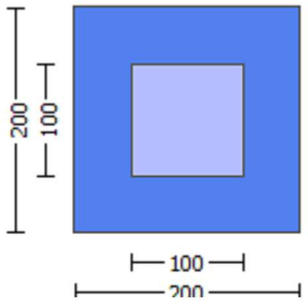
Limit State: Operational Level (data interpolation between analysis steps 50 and 51)

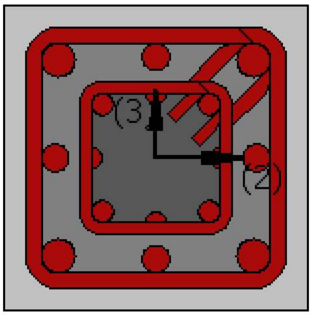
Analysis: Uniform +X

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00

Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.02878
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
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -1.1598602E-029
EDGE -B-
Shear Force, Vb = 1.1598602E-029
BOTH EDGES
Axial Force, F = -954435.753
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141

Calculation of Shear Capacity ratio , Ve/Vr = 0.43225659
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 113270.442
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.6991E+008
Mu1+ = 1.6991E+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- = 1.6991E+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-) = 1.6991E+008
Mu2+ = 1.6991E+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- = 1.6991E+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 = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002

ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone

--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531

No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00

fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00

d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008

ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->

Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00

h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 262044.453

Calculation of Shear Strength at edge 1, Vr1 = 262044.453
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 3.6564195E-010
Vu = 1.1598602E-029
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 262044.453
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 3.6564195E-010
Vu = 1.1598602E-029
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:

d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.02878
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
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 7.1018611E-046
EDGE -B-

Shear Force, Vb = -7.1018611E-046
BOTH EDGES
Axial Force, F = -954435.753
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141

Calculation of Shear Capacity ratio , Ve/Vr = 0.43225659
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 113270.442
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.6991E+008
Mu1+ = 1.6991E+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- = 1.6991E+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-) = 1.6991E+008
Mu2+ = 1.6991E+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- = 1.6991E+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 = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552

Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered

characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->

v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00

Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45

εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->

φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00

From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->

v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
   - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
   - N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
   - σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 262044.453

Calculation of Shear Strength at edge 1, Vr1 = 262044.453
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 262044.453
   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 = 2.9879866E-010
      Vu = 7.1018611E-046
    d = 0.8*h = 160.00
    Nu = 954435.753

Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 262044.453
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 2.9879866E-010
Vu = 7.1018611E-046
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
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
Adequate Lap Length (lb/ld>=1)
No FRP Wrapping

Stepwise Properties

Bending Moment, M = 5.8770792E-007
Shear Force, V2 = 2372.544
Shear Force, V3 = 4.1216227E-010
Axial Force, F = -952838.426
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 1014.734
-Compression: Asl,com,jacket = 1014.734
-Middle: Asl,mid,jacket = 508.938
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 = 17.33333

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.01988947
θu = θy + θp = 0.01988947

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.01883613 ((4.29),Biskinis Phd))
My = 9.4932E+007
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 = 2.5199E+012
factor = 0.70
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 952838.426
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5999E+012

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0448288E-005
with fy = 555.56
d = 166.00
ξy = 0.58629312
A = 0.16521104
B = 0.12006404
with pt = 0.0095295
pc = 0.04447435
pv = 0.02460283
N = 952838.426
b = 200.00
δ" = 0.20481928
Φy_comp = 1.8654349E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.71046623
A = 0.04832572
B = 0.06840454
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

- Calculation of θp -

From table 10-8: θp = 0.00105334
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.43225659
d = d_external = 166.00
s = s_external = 150.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.0095295
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00785398
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 200.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00167552
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 100.00
s2 = 150.00
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 = 952838.426
Ag = 40000.00
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) = 0.11355154
b = 200.00
d = 166.00
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

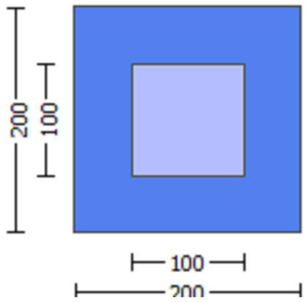
Limit State: Operational Level (data interpolation between analysis steps 50 and 51)

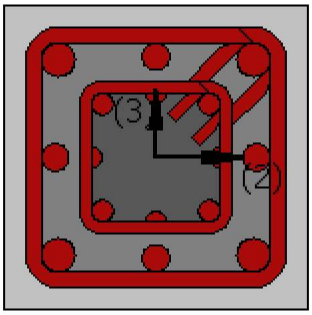
Analysis: Uniform +X

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
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
Adequate Lap Length (lo/lou,min = lb/ld >=1)
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -3.7448736E-006
Shear Force, Va = -4.1216227E-010
EDGE -B-
Bending Moment, Mb = 5.8770792E-007
Shear Force, Vb = 4.1216227E-010
BOTH EDGES
Axial Force, F = -952838.426
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141
Mean Diameter of Tension Reinforcement, DbL,ten = 17.33333

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 235826.482
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 235826.482
VCol = 235826.482
knl = 1.00
displacement_ductility_demand = 3.2973624E-014

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 = 5.8770792E-007
Vu = 4.1216227E-010
d = 0.8*h = 160.00
Nu = 952838.426
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 125663.706
where:
Vs1 = 125663.706 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 500.00
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 106288.613
bw = 200.00

----
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 = 6.2182456E-016
θy = (My*Ls/3)/Eleff = 0.01883613 ((4.29),Biskinis Phd))
My = 9.4932E+007
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 = 2.5199E+012
factor = 0.70
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 952838.426
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5999E+012

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0448288E-005
with fy = 555.56
d = 166.00
ξy = 0.58629312
A = 0.16521104
B = 0.12006404
with pt = 0.04447435
pc = 0.04447435
pv = 0.02460283
N = 952838.426
b = 200.00
δ'' = 0.20481928
Φy_comp = 1.8654349E-005
with fc = 33.00
Ec = 26999.444

ξy = 0.71046623
A = 0.04832572
B = 0.06840454
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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

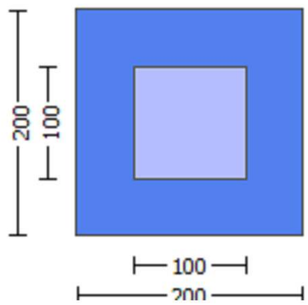
Limit State: Operational Level (data interpolation between analysis steps 50 and 51)

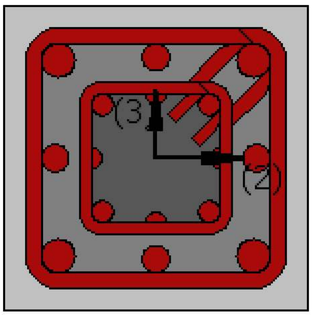
Analysis: Uniform +X

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.02878
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
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -1.1598602E-029
EDGE -B-
Shear Force, Vb = 1.1598602E-029
BOTH EDGES
Axial Force, F = -954435.753
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141

Calculation of Shear Capacity ratio , Ve/Vr = 0.43225659
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 113270.442
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.6991E+008
Mu1+ = 1.6991E+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- = 1.6991E+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-) = 1.6991E+008
Mu2+ = 1.6991E+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- = 1.6991E+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 = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00

εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->

```
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
  - σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) =  8.6451905E-005
Mu = MRc
-----------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
--------------------------------------------------------------------------
--------------------------------------------------------------------------
--------------------------------------------------------------------------
Calculation of Mu1-
--------------------------------------------------------------------------

--------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
--------------------------------------------------------------------------
with full section properties:
  b = 200.00
  d = 166.00
  d' = 34.00
  v = 0.87115348
    N = 954435.753
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01061002
    ωwe (5.4c) = 0.03159521
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
        ase1 = 0.15755208
          bo_1 = 160.00
          ho_1 = 160.00
          Σbi2_1 = 102400.00
      ase2 = Max(ase1,ase2) = 0.15755208
          bo_2 = 92.00
          ho_2 = 92.00
          Σbi2_2 = 33856.00
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
```

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008

----

with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878

εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->

Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
 - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
 - N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
 - σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
 b = 200.00
 d = 166.00
 d' = 34.00
 v = 0.87115348
  N = 954435.753
 fc = 33.00
 εco (5A.5, TBDY) = 0.002
 Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
  The Shear_factor is considered equal to 1 (pure moment strength)
  From (5.4b), TBDY: εcu = 0.01061002
  ωwe (5.4c) = 0.03159521
   ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208

ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied

--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 262044.453

Calculation of Shear Strength at edge 1, Vr1 = 262044.453
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 3.6564195E-010
Vu = 1.1598602E-029
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 262044.453
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 3.6564195E-010
Vu = 1.1598602E-029
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00

Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.02878
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
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 7.1018611E-046
EDGE -B-
Shear Force, Vb = -7.1018611E-046
BOTH EDGES
Axial Force, F = -954435.753
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141

Calculation of Shear Capacity ratio , Ve/Vr = 0.43225659
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 113270.442
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.6991E+008
Mu1+ = 1.6991E+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- = 1.6991E+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-) = 1.6991E+008
Mu2+ = 1.6991E+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- = 1.6991E+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 = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002

ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone

--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531

No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00

```
   fcc (5A.2, TBDY) = 33.94983
   εcc (5A.5, TBDY) = 0.00228783
       λc  = confinement factor = 1.02878
   ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
   ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
   ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6)  is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
   - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
   - N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
   - σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) =  8.6451905E-005
Mu = MRc
--------------------------------------------------------------

Calculation of ratio lb/ld
--------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
Calculation of Mu2+
-----------------------------------------------------------------------------

-----------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
-----------------------------------------------------------------------------
with full section properties:
   b = 200.00
```

d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008

ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->

Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008

----

with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00

h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 262044.453

Calculation of Shear Strength at edge 1, Vr1 = 262044.453
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 2.9879866E-010
Vu = 7.1018611E-046
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 262044.453
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 2.9879866E-010
Vu = 7.1018611E-046
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:

d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
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
Adequate Lap Length (lb/ld>=1)
No FRP Wrapping

Stepwise Properties

Bending Moment, M = -573480.362
Shear Force, V2 = 2372.544
Shear Force, V3 = 4.1216227E-010
Axial Force, F = -952838.426
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141
Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten,jacket = 1014.734
-Compression: Asl,com,jacket = 1014.734
-Middle: Asl,mid,jacket = 508.938
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 = 17.33333

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00482056
θu = θy + θp = 0.00482056

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00376723 ((4.29),Biskinis Phd))
My = 9.4932E+007
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 = 2.5199E+012
factor = 0.70
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 952838.426
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5999E+012

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0448288E-005
with fy = 555.56
d = 166.00
ξy = 0.58629312
A = 0.16521104
B = 0.12006404
with pt = 0.0095295
pc = 0.04447435
pv = 0.02460283
N = 952838.426
b = 200.00
δ'' = 0.20481928
Φy_comp = 1.8654349E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.71046623
A = 0.04832572
B = 0.06840454
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

- Calculation of θp -

From table 10-8: θp = 0.00105334
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VColOE = 0.43225659

d = d_external = 166.00
s = s_external = 150.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.0095295
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00785398
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 200.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00167552
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 100.00
s2 = 150.00
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 = 952838.426
Ag = 40000.00
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) = 0.11355154
b = 200.00
d = 166.00
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

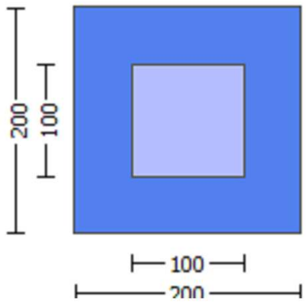
Limit State: Life Safety (data interpolation between analysis steps 50 and 51)

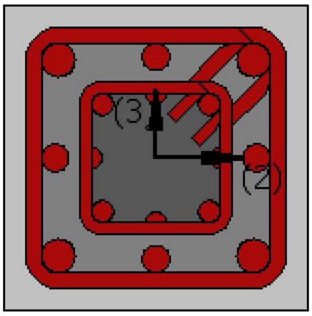
Analysis: Uniform +X

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
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
Adequate Lap Length (lo/lou,min = lb/ld >=1)
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -2.6971E+008
Shear Force, Va = -1653.244

EDGE -B-
Bending Moment, Mb = -448047.023
Shear Force, Vb = 1653.244
BOTH EDGES
Axial Force, F = -952465.534
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1476.549
-Compression: Aslc = 2293.363
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141
Mean Diameter of Tension Reinforcement, DbL,ten = 17.33333

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 171046.073
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 171046.073
VCol = 171046.073
knl = 1.00
displacement_ductility_demand = 1.23043

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 = 2.6971E+008
Vu = 1653.244
d = 0.8*h = 160.00
Nu = 952465.534
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 125663.706
where:
Vs1 = 125663.706 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 500.00
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 106288.613
bw = 200.00

----
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 = 0.09271255
θy = (My*Ls/3)/EIeff = 0.07534979 ((4.29),Biskinis Phd))
My = 9.4939E+007
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 6000.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.5199E+012

factor = 0.70
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 952465.534
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5999E+012

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0444941E-005
with fy = 555.56
d = 166.00
ξy = 0.58625889
A = 0.16519083
B = 0.12004383
with pt = 0.04447435
pc = 0.04447435
pv = 0.02460283
N = 952465.534
b = 200.00
δ" = 0.20481928
Φy_comp = 1.8657650E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.71034051
A = 0.04835124
B = 0.06840454
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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

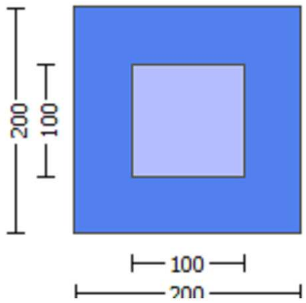
Limit State: Life Safety (data interpolation between analysis steps 50 and 51)

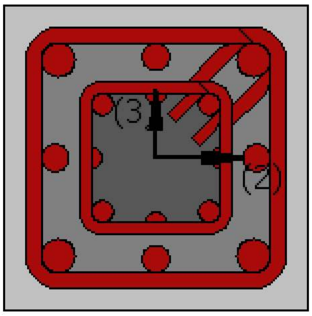
Analysis: Uniform +X

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.02878
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
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -1.1598602E-029
EDGE -B-
Shear Force, Vb = 1.1598602E-029
BOTH EDGES

Axial Force, F = -954435.753
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141

Calculation of Shear Capacity ratio , Ve/Vr = 0.43225659
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 113270.442
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.6991E+008
Mu1+ = 1.6991E+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- = 1.6991E+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-) = 1.6991E+008
Mu2+ = 1.6991E+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- = 1.6991E+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 = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00

h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00

εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->

ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008

----

with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878

εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->

Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
   - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
   - N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
   - σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 262044.453

Calculation of Shear Strength at edge 1, Vr1 = 262044.453
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 262044.453
   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 = 3.6564195E-010
      Vu = 1.1598602E-029
    d = 0.8*h = 160.00
    Nu = 954435.753
    Ag = 40000.00
    From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457

where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 262044.453
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 3.6564195E-010
Vu = 1.1598602E-029
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.02878
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
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 7.1018611E-046
EDGE -B-
Shear Force, Vb = -7.1018611E-046
BOTH EDGES
Axial Force, F = -954435.753
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141

Calculation of Shear Capacity ratio , Ve/Vr = 0.43225659
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 113270.442
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.6991E+008
Mu1+ = 1.6991E+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- = 1.6991E+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-) = 1.6991E+008
Mu2+ = 1.6991E+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- = 1.6991E+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 = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00

From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->

v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
   - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
   - N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
   - σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
   b = 200.00
   d = 166.00
   d' = 34.00
   v = 0.87115348
      N = 954435.753
   fc = 33.00
   εco (5A.5, TBDY) = 0.002
   Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: εcu = 0.01061002

ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone

--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531

No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00

fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00

d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008

ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->

Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 262044.453

Calculation of Shear Strength at edge 1, Vr1 = 262044.453
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 2.9879866E-010
Vu = 7.1018611E-046
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 262044.453
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 2.9879866E-010
Vu = 7.1018611E-046
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
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
Adequate Lap Length (lb/ld>=1)
No FRP Wrapping

Stepwise Properties

Bending Moment, M = -4.3546420E-006
Shear Force, V2 = -1653.244
Shear Force, V3 = -5.2953879E-010
Axial Force, F = -952465.534
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1476.549
-Compression: Aslc = 2293.363
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 1014.734
-Compression: Asl,com,jacket = 1014.734
-Middle: Asl,mid,jacket = 508.938
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 = 17.33333

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.02235465
θu = θy + θp = 0.02235465

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.01883745 ((4.29),Biskinis Phd))
My = 9.4939E+007
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 = 2.5199E+012
factor = 0.70
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 952465.534
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5999E+012

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0444941E-005
with fy = 555.56
d = 166.00

ξy = 0.58625889
A = 0.16519083
B = 0.12004383
with pt = 0.0095295
pc = 0.04447435
pv = 0.02460283
N = 952465.534
b = 200.00
δ" = 0.20481928
Φy_comp = 1.8657650E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.71034051
A = 0.04835124
B = 0.06840454
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

- Calculation of θp -

From table 10-8: θp = 0.0035172
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.43225659
d = d_external = 166.00
s = s_external = 150.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.0095295
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00785398
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 200.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00167552
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 100.00
s2 = 150.00
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 = 952465.534
Ag = 40000.00
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) = 0.11355154
b = 200.00
d = 166.00
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

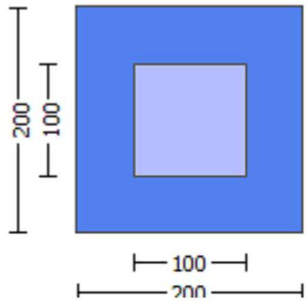
Limit State: Life Safety (data interpolation between analysis steps 50 and 51)

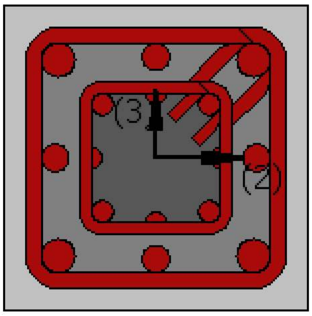
Analysis: Uniform +X

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
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
Adequate Lap Length (lo/lou,min = lb/ld >=1)
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -4.3546420E-006
Shear Force, Va = -5.2953879E-010
EDGE -B-
Bending Moment, Mb = 7.1301600E-007
Shear Force, Vb = 5.2953879E-010
BOTH EDGES
Axial Force, F = -952465.534
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1476.549
-Compression: Aslc = 2293.363
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141
Mean Diameter of Tension Reinforcement, DbL,ten = 17.33333

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 235803.533
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 235803.533
VCol = 235803.533
knl = 1.00
displacement_ductility_demand = 9.7033492E-014

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 = 4.3546420E-006
Vu = 5.2953879E-010
d = 0.8*h = 160.00
Nu = 952465.534
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 125663.706
where:
Vs1 = 125663.706 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965

fy = 500.00
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 106288.613
bw = 200.00

----
displacement_ductility_demand is calculated as θ/θy

- Calculation of θ/θy for END A -
for rotation axis 2 and integ. section (a)

From analysis, chord rotation θ = 1.8279456E-015
θy = (My*Ls/3)/EIeff = 0.01883745 ((4.29),Biskinis Phd))
My = 9.4939E+007
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 = 2.5199E+012
factor = 0.70
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 952465.534
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5999E+012

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0444941E-005
with fy = 555.56
d = 166.00
ξy = 0.58625889
A = 0.16519083
B = 0.12004383
with pt = 0.04447435
pc = 0.04447435
pv = 0.02460283
N = 952465.534
b = 200.00
δ'' = 0.20481928
Φy_comp = 1.8657650E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.71034051
A = 0.04835124
B = 0.06840454
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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

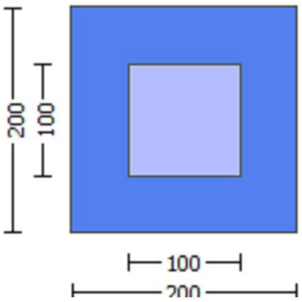
Limit State: Life Safety (data interpolation between analysis steps 50 and 51)

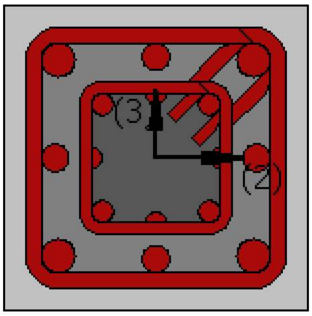
Analysis: Uniform +X

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00

Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.02878
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
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -1.1598602E-029
EDGE -B-
Shear Force, Vb = 1.1598602E-029
BOTH EDGES
Axial Force, F = -954435.753
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141

Calculation of Shear Capacity ratio , Ve/Vr = 0.43225659
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 113270.442
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.6991E+008
Mu1+ = 1.6991E+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- = 1.6991E+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-) = 1.6991E+008
Mu2+ = 1.6991E+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- = 1.6991E+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 = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002

ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone

--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531

No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00

fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00

d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008

ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->

Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00

h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 262044.453

Calculation of Shear Strength at edge 1, Vr1 = 262044.453
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 3.6564195E-010
Vu = 1.1598602E-029
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 262044.453
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 3.6564195E-010
Vu = 1.1598602E-029
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:

d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.02878
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
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 7.1018611E-046
EDGE -B-

Shear Force, Vb = -7.1018611E-046
BOTH EDGES
Axial Force, F = -954435.753
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141

Calculation of Shear Capacity ratio , Ve/Vr = 0.43225659
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 113270.442
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.6991E+008
Mu1+ = 1.6991E+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- = 1.6991E+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-) = 1.6991E+008
Mu2+ = 1.6991E+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- = 1.6991E+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 = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552

Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered

characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->

v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
  - σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008

----

with full section properties:
  b = 200.00
  d = 166.00
  d' = 34.00
  v = 0.87115348
    N = 954435.753
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01061002
    ωwe (5.4c) = 0.03159521
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
        ase1 = 0.15755208
          bo_1 = 160.00
          ho_1 = 160.00
          Σbi2_1 = 102400.00
      ase2 = Max(ase1,ase2) = 0.15755208
          bo_2 = 92.00
          ho_2 = 92.00

Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45

εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->

φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00

From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->

v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 262044.453

Calculation of Shear Strength at edge 1, Vr1 = 262044.453
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 2.9879866E-010
Vu = 7.1018611E-046
d = 0.8*h = 160.00
Nu = 954435.753

Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 262044.453
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 2.9879866E-010
Vu = 7.1018611E-046
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
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
Adequate Lap Length (lb/ld>=1)
No FRP Wrapping

Stepwise Properties

Bending Moment, M = -2.6971E+008
Shear Force, V2 = -1653.244
Shear Force, V3 = -5.2953879E-010
Axial Force, F = -952465.534
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1476.549
-Compression: Aslc = 2293.363
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 1014.734
-Compression: Asl,com,jacket = 1014.734
-Middle: Asl,mid,jacket = 508.938
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 = 17.33333

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.07886699
θu = θy + θp = 0.07886699

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.07534979 ((4.29),Biskinis Phd))
My = 9.4939E+007
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 6000.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.5199E+012
factor = 0.70
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 952465.534
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5999E+012

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0444941E-005
with fy = 555.56
d = 166.00
ξy = 0.58625889
A = 0.16519083
B = 0.12004383
with pt = 0.0095295
pc = 0.04447435
pv = 0.02460283
N = 952465.534
b = 200.00
δ'' = 0.20481928
Φy_comp = 1.8657650E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.71034051
A = 0.04835124
B = 0.06840454
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

- Calculation of θp -

From table 10-8: θp = 0.0035172
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.43225659
d = d_external = 166.00
s = s_external = 150.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.0095295
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00785398
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 200.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00167552
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 100.00
s2 = 150.00
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 = 952465.534
Ag = 40000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00

fyIE = (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) = 0.11355154
b = 200.00
d = 166.00
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

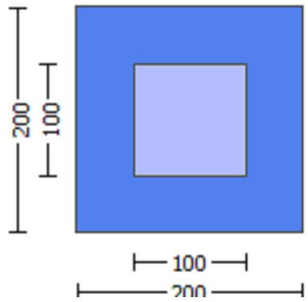
Limit State: Life Safety (data interpolation between analysis steps 50 and 51)

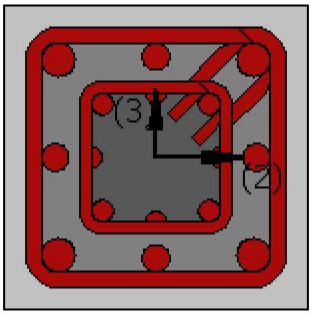
Analysis: Uniform +X

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
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
Adequate Lap Length (lo/lou,min = lb/ld >=1)
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -2.6971E+008
Shear Force, Va = -1653.244
EDGE -B-
Bending Moment, Mb = -448047.023
Shear Force, Vb = 1653.244
BOTH EDGES
Axial Force, F = -952465.534
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141
Mean Diameter of Tension Reinforcement, DbL,ten = 17.33333

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 165062.473
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 165062.473
VCol = 235803.533
knl = 0.70
displacement_ductility_demand = 9.90562

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 = 448047.023
Vu = 1653.244
d = 0.8*h = 160.00
Nu = 952465.534
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 125663.706
where:
Vs1 = 125663.706 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 500.00
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 106288.613
bw = 200.00

----
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 = 0.03731933
θy = (My*Ls/3)/EIeff = 0.00376749 ((4.29),Biskinis Phd))
My = 9.4939E+007
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 = 2.5199E+012
factor = 0.70
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 952465.534
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5999E+012

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0444941E-005
with fy = 555.56
d = 166.00
ξy = 0.58625889
A = 0.16519083
B = 0.12004383
with pt = 0.04447435
pc = 0.04447435
pv = 0.02460283
N = 952465.534
b = 200.00
δ'' = 0.20481928
Φy_comp = 1.8657650E-005
with fc = 33.00
Ec = 26999.444

ξy = 0.71034051
A = 0.04835124
B = 0.06840454
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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

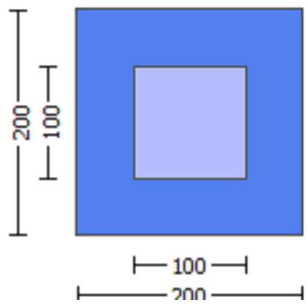
Limit State: Life Safety (data interpolation between analysis steps 50 and 51)

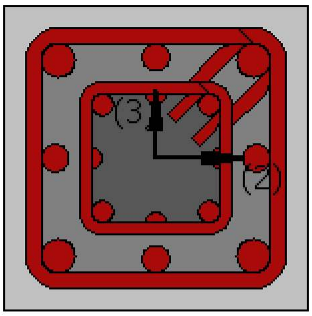
Analysis: Uniform +X

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.02878
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
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -1.1598602E-029
EDGE -B-
Shear Force, Vb = 1.1598602E-029
BOTH EDGES
Axial Force, F = -954435.753
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141

Calculation of Shear Capacity ratio , Ve/Vr = 0.43225659
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 113270.442
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.6991E+008
Mu1+ = 1.6991E+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- = 1.6991E+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-) = 1.6991E+008
Mu2+ = 1.6991E+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- = 1.6991E+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 = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00

εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->

ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878

εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->

Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208

ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied

--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 262044.453

Calculation of Shear Strength at edge 1, Vr1 = 262044.453
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 3.6564195E-010
Vu = 1.1598602E-029
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 262044.453
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 3.6564195E-010
Vu = 1.1598602E-029
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00

Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.02878
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
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 7.1018611E-046
EDGE -B-
Shear Force, Vb = -7.1018611E-046
BOTH EDGES
Axial Force, F = -954435.753
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141

Calculation of Shear Capacity ratio , Ve/Vr = 0.43225659
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 113270.442
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.6991E+008
Mu1+ = 1.6991E+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- = 1.6991E+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-) = 1.6991E+008
Mu2+ = 1.6991E+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- = 1.6991E+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 = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002

ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone

```
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) =  8.6451905E-005
Mu = MRc
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu1-
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
---------------------------------------------------------------------------
with full section properties:
   b = 200.00
   d = 166.00
   d' = 34.00
   v = 0.87115348
      N = 954435.753
   fc = 33.00
   εco (5A.5, TBDY) = 0.002
   Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: εcu = 0.01061002
      ωwe (5.4c) = 0.03159521
         ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
            ase1 = 0.15755208
               bo_1 = 160.00
               ho_1 = 160.00
               Σbi2_1 = 102400.00
         ase2 = Max(ase1,ase2) = 0.15755208
               bo_2 = 92.00
               ho_2 = 92.00
               Σbi2_2 = 33856.00
         psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
      ------------------------------------------------------------------
         psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
            ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
               Ash1 = Astir_1*ns_1 = 157.0796
                  No stirups, ns_1 = 2.00
               h1 = 200.00
            ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
               Ash2 = Astir_2*ns_2 = 100.531
                  No stirups, ns_2 = 2.00
               h2 = 100.00
      ------------------------------------------------------------------
         psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
            ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
               Ash1 = Astir_1*ns_1 = 157.0796
                  No stirups, ns_1 = 2.00
               h1 = 200.00
            ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
               Ash2 = Astir_2*ns_2 = 100.531
```

No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00

fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00

d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008

ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->

Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00

h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 262044.453

Calculation of Shear Strength at edge 1, Vr1 = 262044.453
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 2.9879866E-010
Vu = 7.1018611E-046
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 262044.453
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 2.9879866E-010
Vu = 7.1018611E-046
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:

d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
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
Adequate Lap Length (lb/ld>=1)
No FRP Wrapping

Stepwise Properties

Bending Moment, M = 7.1301600E-007
Shear Force, V2 = 1653.244
Shear Force, V3 = 5.2953879E-010
Axial Force, F = -952465.534
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141
Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten,jacket = 1014.734
-Compression: Asl,com,jacket = 1014.734
-Middle: Asl,mid,jacket = 508.938
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 = 17.33333

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.02235465
θu = θy + θp = 0.02235465

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.01883745 ((4.29),Biskinis Phd))
My = 9.4939E+007
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 = 2.5199E+012
factor = 0.70
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 952465.534
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5999E+012

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0444941E-005
with fy = 555.56
d = 166.00
ξy = 0.58625889
A = 0.16519083
B = 0.12004383
with pt = 0.0095295
pc = 0.04447435
pv = 0.02460283
N = 952465.534
b = 200.00
δ'' = 0.20481928
Φy_comp = 1.8657650E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.71034051
A = 0.04835124
B = 0.06840454
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

- Calculation of θp -

From table 10-8: θp = 0.0035172
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VColOE = 0.43225659

d = d_external = 166.00
s = s_external = 150.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.0095295
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00785398
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 200.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00167552
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 100.00
s2 = 150.00
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 = 952465.534
Ag = 40000.00
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) = 0.11355154
b = 200.00
d = 166.00
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

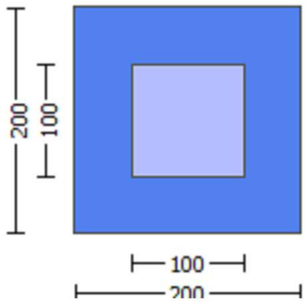
Limit State: Life Safety (data interpolation between analysis steps 50 and 51)

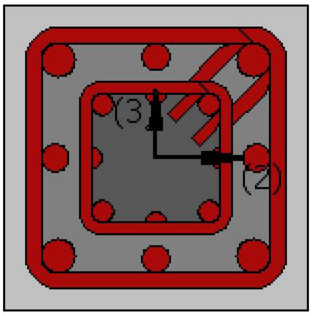
Analysis: Uniform +X

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
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
Adequate Lap Length (lo/lou,min = lb/ld >=1)
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -4.3546420E-006
Shear Force, Va = -5.2953879E-010

EDGE -B-
Bending Moment, Mb = 7.1301600E-007
Shear Force, Vb = 5.2953879E-010
BOTH EDGES
Axial Force, F = -952465.534
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141
Mean Diameter of Tension Reinforcement, DbL,ten = 17.33333

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 235803.533
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 235803.533
VCol = 235803.533
knl = 1.00
displacement_ductility_demand = 3.8524739E-014

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 = 7.1301600E-007
Vu = 5.2953879E-010
d = 0.8*h = 160.00
Nu = 952465.534
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 125663.706
where:
Vs1 = 125663.706 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 500.00
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 106288.613
bw = 200.00

----
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 = 7.2669656E-016
θy = (My*Ls/3)/EIeff = 0.01883745 ((4.29),Biskinis Phd))
My = 9.4939E+007
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 = 2.5199E+012

factor = 0.70
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 952465.534
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5999E+012

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0444941E-005
with fy = 555.56
d = 166.00
ξy = 0.58625889
A = 0.16519083
B = 0.12004383
with pt = 0.04447435
pc = 0.04447435
pv = 0.02460283
N = 952465.534
b = 200.00
δ'' = 0.20481928
Φy_comp = 1.8657650E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.71034051
A = 0.04835124
B = 0.06840454
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

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

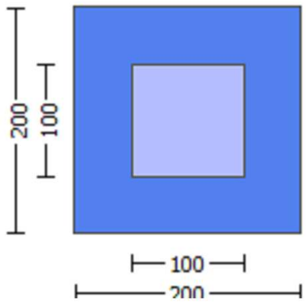
Limit State: Life Safety (data interpolation between analysis steps 50 and 51)

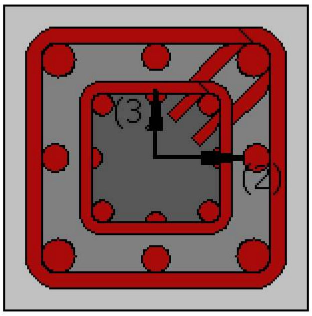
Analysis: Uniform +X

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.02878
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
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -1.1598602E-029
EDGE -B-
Shear Force, Vb = 1.1598602E-029
BOTH EDGES

Axial Force, F = -954435.753
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141

Calculation of Shear Capacity ratio , Ve/Vr = 0.43225659
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 113270.442
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.6991E+008
Mu1+ = 1.6991E+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- = 1.6991E+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-) = 1.6991E+008
Mu2+ = 1.6991E+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- = 1.6991E+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 = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00

h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00

εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->

ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
 - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
 - N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
 - σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
 b = 200.00
 d = 166.00
 d' = 34.00
 v = 0.87115348
  N = 954435.753
 fc = 33.00
 εco (5A.5, TBDY) = 0.002
 Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
  The Shear_factor is considered equal to 1 (pure moment strength)
  From (5.4b), TBDY: εcu = 0.01061002
  ωwe (5.4c) = 0.03159521
   ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
    ase1 = 0.15755208
     bo_1 = 160.00
     ho_1 = 160.00
     Σbi2_1 = 102400.00
   ase2 = Max(ase1,ase2) = 0.15755208
     bo_2 = 92.00
     ho_2 = 92.00
     Σbi2_2 = 33856.00
   psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878

εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->

Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
  - σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 262044.453

Calculation of Shear Strength at edge 1, Vr1 = 262044.453
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 262044.453
  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 = 3.6564195E-010
    Vu = 1.1598602E-029
  d = 0.8*h = 160.00
  Nu = 954435.753
  Ag = 40000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457

where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 262044.453
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 3.6564195E-010
Vu = 1.1598602E-029
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.02878
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
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 7.1018611E-046
EDGE -B-
Shear Force, Vb = -7.1018611E-046
BOTH EDGES
Axial Force, F = -954435.753
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141

Calculation of Shear Capacity ratio , Ve/Vr = 0.43225659
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 113270.442
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.6991E+008
Mu1+ = 1.6991E+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- = 1.6991E+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-) = 1.6991E+008
Mu2+ = 1.6991E+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- = 1.6991E+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 = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00

From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->

v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
 - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
 - N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
 - σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
 b = 200.00
 d = 166.00
 d' = 34.00
 v = 0.87115348
  N = 954435.753
 fc = 33.00
 εco (5A.5, TBDY) = 0.002
 Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
  The Shear_factor is considered equal to 1 (pure moment strength)
  From (5.4b), TBDY: εcu = 0.01061002

ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone

--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00
d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531

No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008
ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00

fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6451905E-005
Mu = 1.6991E+008
----
with full section properties:
b = 200.00

d = 166.00
d' = 34.00
v = 0.87115348
N = 954435.753
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01061002
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01061002
ωwe (5.4c) = 0.03159521
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.15755208
ase1 = 0.15755208
bo_1 = 160.00
ho_1 = 160.00
Σbi2_1 = 102400.00
ase2 = Max(ase1,ase2) = 0.15755208
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.61776
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.61776
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00785398
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 200.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00167552
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00

Asec = 40000.00
s1 = 100.00
s2 = 150.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00228783
λc = confinement factor = 1.02878
εy1 = 0.0025
εsh1 = 0.008
ft1 = 833.34
fy1 = 694.45
εsu1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 694.45
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.0025
εsh2 = 0.008

ft2 = 833.34
fy2 = 694.45
εsu2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 694.45
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 833.34
fyv = 694.45
εsuv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 694.45
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.93591561
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.93591561
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.51774055
and confined core properties:
b = 160.00
d = 146.00
d' = 14.00
fcc (5A.2, TBDY) = 33.94983
εcc (5A.5, TBDY) = 0.00228783
λc = confinement factor = 1.02878
ω1 = Asl,ten/(b*d)*(fs1/fc) = 1.33015
ω2 = Asl,com/(b*d)*(fs2/fc) = 1.33015
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.73582989
Case/Assumption: Unconfinesd full section - Steel rupture
δ' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.7393216
MRc (4.17) = 1.6991E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
- σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->

Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.65248434
MRo (4.18) = 1.2423E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 8.6451905E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 262044.453

Calculation of Shear Strength at edge 1, Vr1 = 262044.453
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 2.9879866E-010
Vu = 7.1018611E-046
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 262044.453
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 262044.453
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 = 2.9879866E-010
Vu = 7.1018611E-046
d = 0.8*h = 160.00
Nu = 954435.753
Ag = 40000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 139627.457
where:
Vs1 = 139627.457 is calculated for jacket, with:
d = 160.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.625
Vs2 = 0.00 is calculated for core, with:
d = 80.00
Av = 100530.965
fy = 555.56
s = 150.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.875
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 122116.319
bw = 200.00

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 = 200.00
External Width, W = 200.00
Internal Height, H = 100.00
Internal Width, W = 100.00
Cover Thickness, c = 15.00
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
Adequate Lap Length (lb/ld>=1)
No FRP Wrapping

Stepwise Properties

Bending Moment, M = -448047.023
Shear Force, V2 = 1653.244
Shear Force, V3 = 5.2953879E-010
Axial Force, F = -952465.534
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3769.911
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1476.549
-Compression: Asl,com = 1476.549
-Middle: Asl,mid = 816.8141
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 1014.734
-Compression: Asl,com,jacket = 1014.734
-Middle: Asl,mid,jacket = 508.938
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 = 17.33333

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00728469
θu = θy + θp = 0.00728469

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00376749 ((4.29),Biskinis Phd))
My = 9.4939E+007
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 = 2.5199E+012
factor = 0.70
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 952465.534
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5999E+012

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 4.0444941E-005
with fy = 555.56
d = 166.00

ξy = 0.58625889
A = 0.16519083
B = 0.12004383
with pt = 0.0095295
pc = 0.04447435
pv = 0.02460283
N = 952465.534
b = 200.00
δ" = 0.20481928
Φy_comp = 1.8657650E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.71034051
A = 0.04835124
B = 0.06840454
with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

- Calculation of θp -

From table 10-8: θp = 0.0035172
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.43225659
d = d_external = 166.00
s = s_external = 150.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.0095295
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00785398
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 200.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00167552
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 100.00
s2 = 150.00
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 = 952465.534
Ag = 40000.00
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) = 0.11355154
b = 200.00
d = 166.00
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)
