# Detailed Member Calculations

**Units: N&mm**

**Regulation: ASCE 41-17**

## Calculation No. 1

column C1, Floor 1

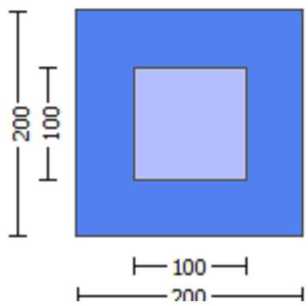
Limit State: Operational Level (data interpolation between analysis steps 50 and 51)

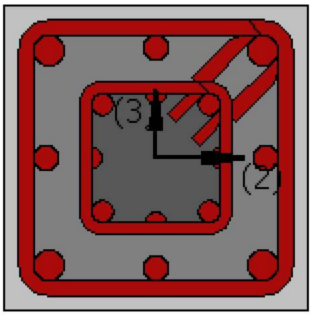
Analysis: Uniform +X

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 = 10.00
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 = -1.1120E+008
Shear Force, Va = -31530.033
EDGE -B-
Bending Moment, Mb = -6.2875E+006
Shear Force, Vb = 31530.033
BOTH EDGES
Axial Force, F = -218376.72
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 2001.195
-Compression: Aslc = 1291.195
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
Mean Diameter of Tension Reinforcement, DbL,ten = 17.50
---------------------------------------------------------------
---------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 141974.841
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 141974.841
VCol = 141974.841
knl = 1.00
displacement_ductility_demand = 0.38472951
---------------------------------------------------------------
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 = 1.1120E+008
Vu = 31530.033
d = 0.8*h = 160.00
Nu = 218376.72
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 0.0348697
θy = (My*Ls/3)/Eleff = 0.09063433 ((4.29),Biskinis Phd))
My = 1.0142E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3526.931
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 1.3155E+012
factor = 0.36543691
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 218376.72
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 = 3.1090581E-005
with fy = 555.56
d = 172.00
ξy = 0.48055007
A = 0.10713558
B = 0.06707136
with pt = 0.02858484
pc = 0.02858484
pv = 0.03853931
N = 218376.72
b = 200.00
δ'' = 0.1627907
Φy_comp = 2.6245742E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.48735376

A = 0.08128164
B = 0.05564476
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

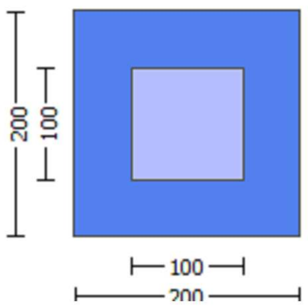
Limit State: Operational Level (data interpolation between analysis steps 50 and 51)

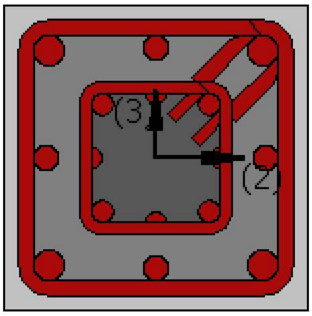
Analysis: Uniform +X

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 = 10.00
Mean Confinement Factor overall section = 1.06329
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 = -8.1187678E-030
EDGE -B-
Shear Force, Vb = 8.1187678E-030
BOTH EDGES
Axial Force, F = -219397.073
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.4563967
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 91510.703
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.3727E+008
Mu1+ = 1.3727E+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- = 1.3727E+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-) = 1.3727E+008
Mu2+ = 1.3727E+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- = 1.3727E+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 = 3.2469244E-005
Mu = 1.3727E+008
----------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied

--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
------------------------------------------------------------

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
---------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233

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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
-----------------------------------------------------------------

Calculation of ratio lb/ld

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

----------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
----------------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
------------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
------------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
------------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce  = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc  = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.

--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6)  is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
-----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
--------------------------------------------------------------------------------
with full section properties:
   b = 200.00
   d = 172.00
   d' = 28.00
   v = 0.19326733
      N = 219397.073
   fc = 33.00
   εco (5A.5, TBDY) = 0.002
   Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: εcu = 0.01053874
      ωwe (5.4c) = 0.03096488
         ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
            ase1 = 0.16608997
               bo_1 = 170.00
               ho_1 = 170.00
               Σbi2_1 = 115600.00

ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
----------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622

MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 200506.935
--------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 200506.935
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
knl = 1 (zero step-static loading)
-----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0616465E-011
Vu = 8.1187678E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 200506.935
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
knl = 1 (zero step-static loading)
-----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0616465E-011
Vu = 8.1187678E-030

d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 10.00
Mean Confinement Factor overall section = 1.06329
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 = -1.9686856E-030
EDGE -B-
Shear Force, Vb = 1.9686856E-030
BOTH EDGES
Axial Force, F = -219397.073
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.4563967
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 91510.703
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.3727E+008
Mu1+ = 1.3727E+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- = 1.3727E+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-) = 1.3727E+008
Mu2+ = 1.3727E+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- = 1.3727E+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 = 3.2469244E-005
Mu = 1.3727E+008
--------------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00

Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->

```
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
-----------------------------------------------------------------

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


--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
--------------------------------------------------------------------------------
with full section properties:
  b = 200.00
  d = 172.00
  d' = 28.00
  v = 0.19326733
     N = 219397.073
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: εcu = 0.01053874
     ωwe (5.4c) = 0.03096488
        ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
           ase1 = 0.16608997
              bo_1 = 170.00
              ho_1 = 170.00
              Σbi2_1 = 115600.00
        ase2 = Max(ase1,ase2) = 0.16608997
              bo_2 = 92.00
              ho_2 = 92.00
              Σbi2_2 = 33856.00
        psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
     ------------------------------------------------------------------------
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
           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 = 0.00100531
              Ash2 = Astir_2*ns_2 = 100.531
                 No stirups, ns_2 = 2.00
              h2 = 100.00
     ------------------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
           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 = 0.00100531
              Ash2 = Astir_2*ns_2 = 100.531
                 No stirups, ns_2 = 2.00
              h2 = 100.00
     ------------------------------------------------------------------------
           Asec = 40000.00
           s1 = 100.00
           s2 = 250.00
```

fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453

Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6)  is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
------------------------------------------------------------

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
---------------------------------------------------------------------------
with full section properties:
 b = 200.00
 d = 172.00
 d' = 28.00
 v = 0.19326733
  N = 219397.073
 fc = 33.00
 εco (5A.5, TBDY) = 0.002
 Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874

The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
--------------------------------------------------------------------------------
with full section properties:
  b = 200.00
  d = 172.00
  d' = 28.00
  v = 0.19326733
     N = 219397.073
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: εcu = 0.01053874
     ωwe (5.4c) = 0.03096488
        ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
           ase1 = 0.16608997
              bo_1 = 170.00
              ho_1 = 170.00
              Σbi2_1 = 115600.00
        ase2 = Max(ase1,ase2) = 0.16608997
              bo_2 = 92.00
              ho_2 = 92.00
              Σbi2_2 = 33856.00
        psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
     -----------------------------------------------------------------------
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
           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 = 0.00100531
              Ash2 = Astir_2*ns_2 = 100.531
                 No stirups, ns_2 = 2.00
              h2 = 100.00
     -----------------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
           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 = 0.00100531
```

Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00

d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc  = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6)  is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 200506.935
--------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 200506.935
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
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 = 2.0213315E-011
Vu = 1.9686856E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 200506.935
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
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 = 2.0213315E-011
Vu = 1.9686856E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 10.00
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 = -6.6699040E-008
Shear Force, V2 = -31530.033
Shear Force, V3 = 4.1944085E-011
Axial Force, F = -218376.72
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 2001.195
-Compression: Aslc = 1291.195
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 829.3805
-Compression: Asl,com,jacket = 829.3805
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 153.938
-Compression: Asl,com,core = 153.938
-Middle: Asl,mid,core = 923.6282
Mean Diameter of Tension Reinforcement, DbL = 17.50
---------------------------------------------------------------

---------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.04304225
θu = θy + θp = 0.04304225

---------------------------------------------------------------
- Calculation of θy -
---------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.03854669 ((4.29),Biskinis Phd))
My = 1.0142E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3155E+012
factor = 0.36543691
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 218376.72
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 = 3.1090581E-005
with fy = 555.56
d = 172.00
ξy = 0.48055007
A = 0.10713558
B = 0.06707136
with pt = 0.02858484
pc = 0.02858484
pv = 0.03853931
N = 218376.72
b = 200.00
δ'' = 0.1627907
Φy_comp = 2.6245742E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.48735376
A = 0.08128164
B = 0.05564476
with Es = 200000.00
---------------------------------------------------------------

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

---------------------------------------------------------------
- Calculation of θp -
---------------------------------------------------------------
From table 10-8: θp = 0.00449557
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VColOE = 0.4563967
d = d_external = 172.00
s = s_external = 150.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00885929
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) = 0.00100531
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction

h2 = 100.00
s2 = 250.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
For the normalisation fs of jacket is used.
NUD = 218376.72
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*ρs1+fy_int_Trans_Reinf*ρs2)/(ρs1+ρs2) = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.09570899
b = 200.00
d = 172.00
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

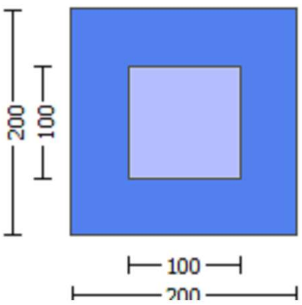
Limit State: Operational Level (data interpolation between analysis steps 50 and 51)

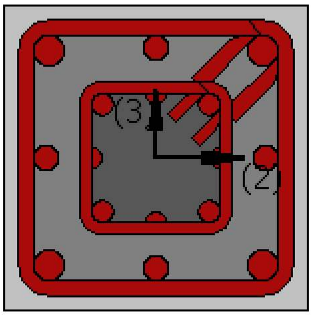
Analysis: Uniform +X

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 = 10.00
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 = -6.6699040E-008
Shear Force, Va = 4.1944085E-011
EDGE -B-
Bending Moment, Mb = -6.0481164E-008
Shear Force, Vb = -4.1944085E-011
BOTH EDGES
Axial Force, F = -218376.72
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 2001.195
-Compression: Aslc = 1291.195
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
Mean Diameter of Tension Reinforcement, DbL,ten = 17.50
---------------------------------------------------------------
---------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 177661.069
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 177661.069
VCol = 177661.069

knl = 1.00
displacement_ductility_demand = 0.00
---------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
---------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 6.6699040E-008
Vu = 4.1944085E-011
d = 0.8*h = 160.00
Nu = 218376.72
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 2.0709479E-018
θy = (My*Ls/3)/EIeff = 0.03854669 ((4.29),Biskinis Phd))
My = 1.0142E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3155E+012
factor = 0.36543691
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 218376.72
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 = 3.1090581E-005
with fy = 555.56
d = 172.00
ξy = 0.48055007
A = 0.10713558
B = 0.06707136
with pt = 0.02858484

pc = 0.02858484
pv = 0.03853931
N = 218376.72
b = 200.00
δ" = 0.1627907
Φy_comp = 2.6245742E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.48735376
A = 0.08128164
B = 0.05564476
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

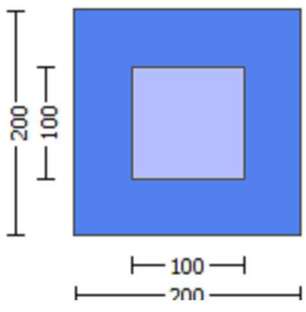
Limit State: Operational Level (data interpolation between analysis steps 50 and 51)

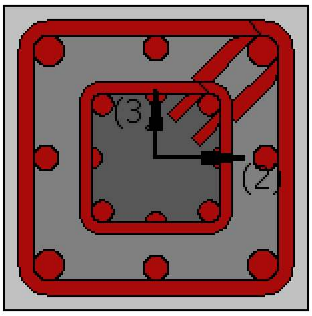
Analysis: Uniform +X

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 = 10.00
Mean Confinement Factor overall section = 1.06329
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 = -8.1187678E-030
EDGE -B-
Shear Force, Vb = 8.1187678E-030
BOTH EDGES
Axial Force, F = -219397.073
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.4563967
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 91510.703
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.3727E+008
Mu1+ = 1.3727E+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- = 1.3727E+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-) = 1.3727E+008
Mu2+ = 1.3727E+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- = 1.3727E+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 = 3.2469244E-005
Mu = 1.3727E+008
---------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied

--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6)  is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
------------------------------------------------------------

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
---------------------------------------------------------------------------
with full section properties:
   b = 200.00
   d = 172.00
   d' = 28.00
   v = 0.19326733
      N = 219397.073
   fc = 33.00
   εco (5A.5, TBDY) = 0.002
   Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: εcu = 0.01053874
      ωwe (5.4c) = 0.03096488
         ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
            ase1 = 0.16608997
               bo_1 = 170.00

ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
-------------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied

--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
------------------------------------------------------------

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
---------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00

s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517

ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6)  is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
-------------------------------------------------------------

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

----------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
----------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
--------------------------------------------------------------------------
--------------------------------------------------------------------------
--------------------------------------------------------------------------
--------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 200506.935
--------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 200506.935
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
knl = 1 (zero step-static loading)
------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0616465E-011
Vu = 8.1187678E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 200506.935
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
knl = 1 (zero step-static loading)
------------------------------------------------------------

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0616465E-011
Vu = 8.1187678E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 10.00
Mean Confinement Factor overall section = 1.06329
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 = -1.9686856E-030
EDGE -B-
Shear Force, Vb = 1.9686856E-030
BOTH EDGES
Axial Force, F = -219397.073
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.4563967
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 91510.703
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.3727E+008
Mu1+ = 1.3727E+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- = 1.3727E+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-) = 1.3727E+008
Mu2+ = 1.3727E+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- = 1.3727E+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 = 3.2469244E-005
Mu = 1.3727E+008
----------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00

εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
------------------------------------------------------------

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
---------------------------------------------------------------------------
with full section properties:
  b = 200.00
  d = 172.00
  d' = 28.00
  v = 0.19326733
     N = 219397.073
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: εcu = 0.01053874
     ωwe (5.4c) = 0.03096488
        ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
           ase1 = 0.16608997
              bo_1 = 170.00
              ho_1 = 170.00
              Σbi2_1 = 115600.00
        ase2 = Max(ase1,ase2) = 0.16608997
              bo_2 = 92.00
              ho_2 = 92.00
              Σbi2_2 = 33856.00
        psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
     ------------------------------------------------------------------
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
           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 = 0.00100531
              Ash2 = Astir_2*ns_2 = 100.531
                 No stirups, ns_2 = 2.00
              h2 = 100.00
     ------------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
           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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:

b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
--------------------------------------------------------------------------------

with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
--------------------------------------------------------------

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

-----------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
-----------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531

No stirups, ns_2 = 2.00
h2 = 100.00
-----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc  = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6)  is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
----------------------------------------------------------------

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

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 200506.935
---------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 200506.935
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
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 = 2.0213315E-011
Vu = 1.9686856E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 200506.935
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
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 = 2.0213315E-011
Vu = 1.9686856E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 10.00
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 = -1.1120E+008
Shear Force, V2 = -31530.033
Shear Force, V3 = 4.1944085E-011
Axial Force, F = -218376.72
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 2001.195
-Compression: Aslc = 1291.195
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten,jacket = 829.3805
-Compression: Asl,com,jacket = 829.3805
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 153.938
-Compression: Asl,com,core = 153.938
-Middle: Asl,mid,core = 923.6282
Mean Diameter of Tension Reinforcement, DbL = 17.50
-----------------------------------------------------------------
-----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.0951299
θu = θy + θp = 0.0951299

-----------------------------------------------------------------
- Calculation of θy -
-----------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.09063433 ((4.29),Biskinis Phd))
My = 1.0142E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3526.931
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3155E+012
factor = 0.36543691
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 218376.72
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 = 3.1090581E-005
with fy = 555.56
d = 172.00
ξy = 0.48055007
A = 0.10713558
B = 0.06707136
with pt = 0.02858484
pc = 0.02858484
pv = 0.03853931
N = 218376.72
b = 200.00
δ'' = 0.1627907
Φy_comp = 2.6245742E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.48735376
A = 0.08128164
B = 0.05564476
with Es = 200000.00
-----------------------------------------------------------------

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

-----------------------------------------------------------------
- Calculation of θp -
-----------------------------------------------------------------
From table 10-8: θp = 0.00449557
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VColOE = 0.4563967

d = d_external = 172.00
s = s_external = 150.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00885929
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) = 0.00100531
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 100.00
s2 = 250.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
For the normalisation fs of jacket is used.
NUD = 218376.72
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*ρs1+fy_int_Trans_Reinf*ρs2)/(ρs1+ρs2) = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.09570899
b = 200.00
d = 172.00
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

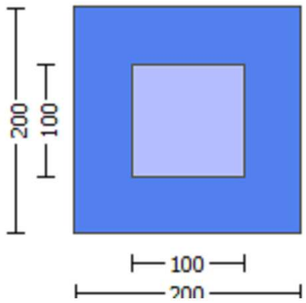
Limit State: Operational Level (data interpolation between analysis steps 50 and 51)

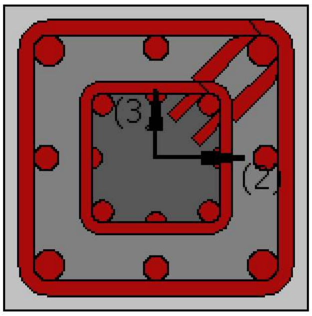
Analysis: Uniform +X

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 = 10.00
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 = -1.1120E+008
Shear Force, Va = -31530.033

EDGE -B-
Bending Moment, Mb = -6.2875E+006
Shear Force, Vb = 31530.033
BOTH EDGES
Axial Force, F = -218376.72
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
Mean Diameter of Tension Reinforcement, DbL,ten = 17.50
------------------------------------------------------------
------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 177661.069
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 177661.069
VCol = 177661.069
knl = 1.00
displacement_ductility_demand = 1.81332
------------------------------------------------------------
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 = 6.2875E+006
Vu = 31530.033
d = 0.8*h = 160.00
Nu = 218376.72
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 0.01397951
θy = (My*Ls/3)/EIeff = 0.00770934 ((4.29),Biskinis Phd))
My = 1.0142E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3155E+012

factor = 0.36543691
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 218376.72
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 = 3.1090581E-005
with fy = 555.56
d = 172.00
ξy = 0.48055007
A = 0.10713558
B = 0.06707136
with pt = 0.02858484
pc = 0.02858484
pv = 0.03853931
N = 218376.72
b = 200.00
δ" = 0.1627907
Φy_comp = 2.6245742E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.48735376
A = 0.08128164
B = 0.05564476
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

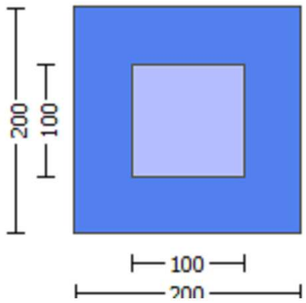
Limit State: Operational Level (data interpolation between analysis steps 50 and 51)

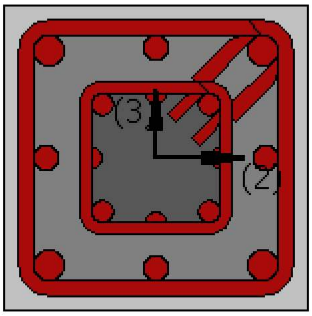
Analysis: Uniform +X

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 = 10.00
Mean Confinement Factor overall section = 1.06329
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 = -8.1187678E-030
EDGE -B-
Shear Force, Vb = 8.1187678E-030
BOTH EDGES

Axial Force, F = -219397.073
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
----------------------------------------------------------
----------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.4563967
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 91510.703
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.3727E+008
Mu1+ = 1.3727E+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- = 1.3727E+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-) = 1.3727E+008
Mu2+ = 1.3727E+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- = 1.3727E+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 = 3.2469244E-005
Mu = 1.3727E+008
-------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
----------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00

h2 = 100.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
-------------------------------------------------------------

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

-----------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
-----------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied

--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
------------------------------------------------------------

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

------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
------------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233

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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc  = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6)  is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
----------------------------------------------------------------

Calculation of ratio lb/ld

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

---------------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
---------------------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
---------------------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
---------------------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
---------------------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.

--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6)  is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 200506.935
------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 200506.935
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 200506.935
   knl = 1 (zero step-static loading)
---------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
---------------------------------------------------------------
   λ = 1 (normal-weight concrete)
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
   M/Vd = 2.00
      Mu = 4.0616465E-011
      Vu = 8.1187678E-030
    d = 0.8*h = 160.00
    Nu = 219397.073
    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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 200506.935
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
knl = 1 (zero step-static loading)

---

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

---

λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0616465E-011
Vu = 8.1187678E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 10.00
Mean Confinement Factor overall section = 1.06329
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 = -1.9686856E-030
EDGE -B-
Shear Force, Vb = 1.9686856E-030
BOTH EDGES
Axial Force, F = -219397.073
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.4563967
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 91510.703
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.3727E+008
Mu1+ = 1.3727E+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- = 1.3727E+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-) = 1.3727E+008

Mu2+ = 1.3727E+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- = 1.3727E+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 = 3.2469244E-005
Mu = 1.3727E+008
---------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->

Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6)  is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
------------------------------------------------------------

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
---------------------------------------------------------------------------
with full section properties:
   b = 200.00
   d = 172.00
   d' = 28.00
   v = 0.19326733
      N = 219397.073
   fc = 33.00
   εco (5A.5, TBDY) = 0.002
   Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: εcu = 0.01053874
      ωwe (5.4c) = 0.03096488
         ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
            ase1 = 0.16608997
               bo_1 = 170.00
               ho_1 = 170.00

Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
-----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->

ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
-----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
--------------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
-------------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00

fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453

Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6)  is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
------------------------------------------------------------

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
---------------------------------------------------------------------------
with full section properties:
  b = 200.00
  d = 172.00
  d' = 28.00
  v = 0.19326733
    N = 219397.073
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874

The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 200506.935
--------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 200506.935
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
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 = 2.0213315E-011
Vu = 1.9686856E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 200506.935
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
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 = 2.0213315E-011
Vu = 1.9686856E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 10.00
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 = -6.0481164E-008
Shear Force, V2 = 31530.033
Shear Force, V3 = -4.1944085E-011
Axial Force, F = -218376.72
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 829.3805
-Compression: Asl,com,jacket = 829.3805
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 153.938
-Compression: Asl,com,core = 153.938
-Middle: Asl,mid,core = 923.6282
Mean Diameter of Tension Reinforcement, DbL = 17.50
---------------------------------------------------------------
---------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.04304225
θu = θy + θp = 0.04304225

---------------------------------------------------------------
- Calculation of θy -
---------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.03854669 ((4.29),Biskinis Phd))
My = 1.0142E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3155E+012
factor = 0.36543691
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 218376.72
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 = 3.1090581E-005
with fy = 555.56
d = 172.00
ξy = 0.48055007
A = 0.10713558
B = 0.06707136
with pt = 0.02858484
pc = 0.02858484
pv = 0.03853931
N = 218376.72
b = 200.00

δ" = 0.1627907
Φy_comp = 2.6245742E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.48735376
A = 0.08128164
B = 0.05564476
with Es = 200000.00

---

Calculation of ratio lb/ld

---

Adequate Lap Length: lb/ld >= 1

---

- Calculation of θp -

---

From table 10-8: θp = 0.00449557
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.4563967
d = d_external = 172.00
s = s_external = 150.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00885929
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) = 0.00100531
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 100.00
s2 = 250.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
For the normalisation fs of jacket is used.
NUD = 218376.72
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*ρs1+fy_int_Trans_Reinf*ρs2)/(ρs1+ρs2) = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.09570899
b = 200.00
d = 172.00
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

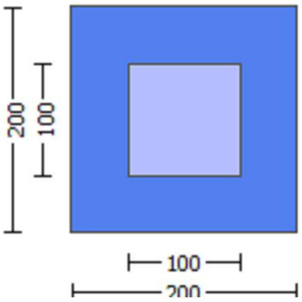
Limit State: Operational Level (data interpolation between analysis steps 50 and 51)

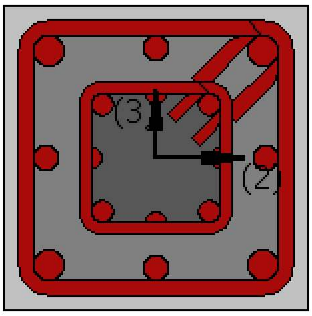
Analysis: Uniform +X

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 = 10.00
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 = -6.6699040E-008
Shear Force, Va = 4.1944085E-011
EDGE -B-
Bending Moment, Mb = -6.0481164E-008
Shear Force, Vb = -4.1944085E-011
BOTH EDGES
Axial Force, F = -218376.72
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
Mean Diameter of Tension Reinforcement, DbL,ten = 17.50
-----------------------------------------------------------------
-----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 177661.069
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 177661.069
VCol = 177661.069
knl = 1.00
displacement_ductility_demand = 0.00
-----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 6.0481164E-008
Vu = 4.1944085E-011
d = 0.8*h = 160.00
Nu = 218376.72
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 2.8425018E-018
θy = (My*Ls/3)/EIeff = 0.03854669 ((4.29),Biskinis Phd))
   My = 1.0142E+008
   Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
   From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3155E+012
      factor = 0.36543691
         Ag = 40000.00
         Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
         N = 218376.72
      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 = 3.1090581E-005
 with fy = 555.56
      d = 172.00
      ξy = 0.48055007
      A = 0.10713558
      B = 0.06707136
       with pt = 0.02858484
          pc = 0.02858484
          pv = 0.03853931
          N = 218376.72
          b = 200.00
          δ'' = 0.1627907
Φy_comp = 2.6245742E-005
 with fc = 33.00
      Ec = 26999.444
      ξy = 0.48735376
      A = 0.08128164
      B = 0.05564476
       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

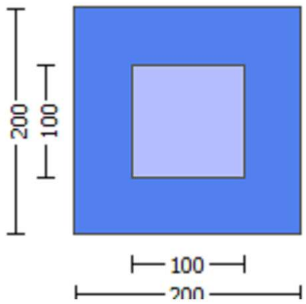
Limit State: Operational Level (data interpolation between analysis steps 50 and 51)

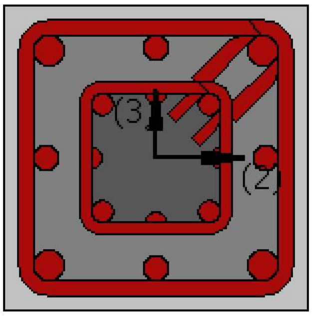
Analysis: Uniform +X

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 = 10.00
Mean Confinement Factor overall section = 1.06329
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 = -8.1187678E-030
EDGE -B-
Shear Force, Vb = 8.1187678E-030
BOTH EDGES
Axial Force, F = -219397.073
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.4563967
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 91510.703
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.3727E+008
Mu1+ = 1.3727E+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- = 1.3727E+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-) = 1.3727E+008
Mu2+ = 1.3727E+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- = 1.3727E+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 = 3.2469244E-005
Mu = 1.3727E+008
--------------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997

bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
----------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008

```
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
--------------------------------------------------------------------------------
with full section properties:
   b = 200.00
   d = 172.00
   d' = 28.00
   v = 0.19326733
      N = 219397.073
   fc = 33.00
   εco (5A.5, TBDY) = 0.002
   Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: εcu = 0.01053874
      ωwe (5.4c) = 0.03096488
         ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
            ase1 = 0.16608997
               bo_1 = 170.00
               ho_1 = 170.00
               Σbi2_1 = 115600.00
         ase2 = Max(ase1,ase2) = 0.16608997
               bo_2 = 92.00
               ho_2 = 92.00
               Σbi2_2 = 33856.00
         psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
      ----------------------------------------------------------------------
         psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
            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 = 0.00100531
               Ash2 = Astir_2*ns_2 = 100.531
                  No stirups, ns_2 = 2.00
               h2 = 100.00
      ----------------------------------------------------------------------
         psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
            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 = 0.00100531
               Ash2 = Astir_2*ns_2 = 100.531
                  No stirups, ns_2 = 2.00
               h2 = 100.00
      ----------------------------------------------------------------------
            Asec = 40000.00
            s1 = 100.00
            s2 = 250.00
         fywe1 = 694.45
         fywe2 = 694.45
```

fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)

--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6)  is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
--------------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874

ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
-----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
--------------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00

h2 = 100.00
-----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866

εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 200506.935
--------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 200506.935
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
knl = 1 (zero step-static loading)
----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
----------------------------------------------------------------
λ = 1 (normal-weight concrete)

Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0616465E-011
Vu = 8.1187678E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 200506.935
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
knl = 1 (zero step-static loading)

---

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

---

λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0616465E-011
Vu = 8.1187678E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 10.00
Mean Confinement Factor overall section = 1.06329
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 = -1.9686856E-030
EDGE -B-
Shear Force, Vb = 1.9686856E-030
BOTH EDGES
Axial Force, F = -219397.073
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
----------------------------------------------------------------

---------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.4563967
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 91510.703
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.3727E+008
Mu1+ = 1.3727E+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- = 1.3727E+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-) = 1.3727E+008
Mu2+ = 1.3727E+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- = 1.3727E+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 = 3.2469244E-005
Mu = 1.3727E+008
------------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531

No stirups, ns_2 = 2.00
h2 = 100.00
-----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00

fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
--------------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00

d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
----------------------------------------------------------------

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

------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
------------------------------------------------------------------------------
with full section properties:
  b = 200.00
  d = 172.00
  d' = 28.00
  v = 0.19326733
    N = 219397.073
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01053874
    ωwe (5.4c) = 0.03096488
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
        ase1 = 0.16608997
          bo_1 = 170.00
          ho_1 = 170.00
          Σbi2_1 = 115600.00
      ase2 = Max(ase1,ase2) = 0.16608997
          bo_2 = 92.00
          ho_2 = 92.00
          Σbi2_2 = 33856.00
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
    ----------------------------------------------------------------------
      psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
        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 = 0.00100531
          Ash2 = Astir_2*ns_2 = 100.531
            No stirups, ns_2 = 2.00
          h2 = 100.00
    ----------------------------------------------------------------------
```

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
-----------------------------------------------------------------

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

--------------------------------------------------------------------------------

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
--------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168

MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
---------------------------------------------------------------------------------
---------------------------------------------------------------------------------
---------------------------------------------------------------------------------
---------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 200506.935
---------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 200506.935
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
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 = 2.0213315E-011
Vu = 1.9686856E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00

Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 200506.935
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
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 = 2.0213315E-011
Vu = 1.9686856E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 10.00
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 = -6.2875E+006
Shear Force, V2 = 31530.033
Shear Force, V3 = -4.1944085E-011
Axial Force, F = -218376.72
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 829.3805
-Compression: Asl,com,jacket = 829.3805
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 153.938
-Compression: Asl,com,core = 153.938
-Middle: Asl,mid,core = 923.6282
Mean Diameter of Tension Reinforcement, DbL = 17.50
-----------------------------------------------------------------
-----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.0122049
θu = θy + θp = 0.0122049

-----------------------------------------------------------------
- Calculation of θy -
-----------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.00770934 ((4.29),Biskinis Phd))
My = 1.0142E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3155E+012
factor = 0.36543691
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 218376.72
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 = 3.1090581E-005
 with fy = 555.56
 d = 172.00
 ξy = 0.48055007
 A = 0.10713558
 B = 0.06707136
 with pt = 0.02858484
 pc = 0.02858484
 pv = 0.03853931
 N = 218376.72
 b = 200.00
 δ" = 0.1627907
Φy_comp = 2.6245742E-005
 with fc = 33.00
 Ec = 26999.444
 ξy = 0.48735376
 A = 0.08128164
 B = 0.05564476
 with Es = 200000.00
---------------------------------------------------------------

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

---------------------------------------------------------------
 - Calculation of θp -
---------------------------------------------------------------
From table 10-8: θp = 0.00449557
with:
 - Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
 shear control ratio VyE/VCol0E = 0.4563967
 d = d_external = 172.00
 s = s_external = 150.00
 ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00885929
 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) = 0.00100531
 Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
 h2 = 100.00
 s2 = 250.00
 The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
 where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
 All these variables have already been given in Shear control ratio calculation.
 For the normalisation fs of jacket is used.
 NUD = 218376.72
 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*ρs1+fy_int_Trans_Reinf*ρs2)/(ρs1+ρs2) = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.09570899
 b = 200.00
 d = 172.00
 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

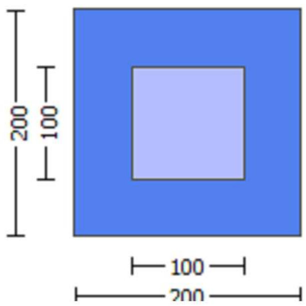
Limit State: Life Safety (data interpolation between analysis steps 50 and 51)

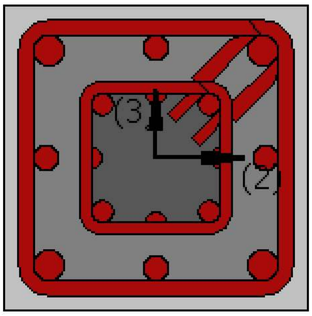
Analysis: Uniform +X

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 = 10.00
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 = -1.3301E+008
Shear Force, Va = -37594.437
EDGE -B-
Bending Moment, Mb = -7.4968E+006
Shear Force, Vb = 37594.437
BOTH EDGES
Axial Force, F = -218084.658
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 2001.195
-Compression: Aslc = 1291.195
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
Mean Diameter of Tension Reinforcement, DbL,ten = 17.50
-----------------------------------------------------------------
-----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 141958.469
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 141958.469
VCol = 141958.469
knl = 1.00
displacement_ductility_demand = 0.46397517
-----------------------------------------------------------------
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 = 1.3301E+008
Vu = 37594.437
d = 0.8*h = 160.00
Nu = 218084.658
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 0.04221101
θy = (My*Ls/3)/Eleff = 0.09097686 ((4.29),Biskinis Phd))
My = 1.0143E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3537.917
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 1.3147E+012
factor = 0.36521565
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 218084.658
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 = 3.1087819E-005
with fy = 555.56
d = 172.00
ξy = 0.48050392
A = 0.1071203
B = 0.06705607
with pt = 0.02858484
pc = 0.02858484
pv = 0.03853931
N = 218084.658
b = 200.00
δ'' = 0.1627907
Φy_comp = 2.6249185E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.48728983
A = 0.08130094
B = 0.05564476
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

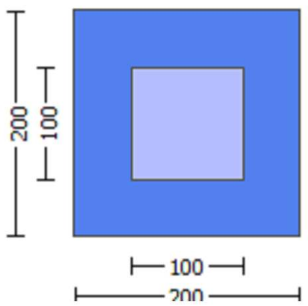
Limit State: Life Safety (data interpolation between analysis steps 50 and 51)

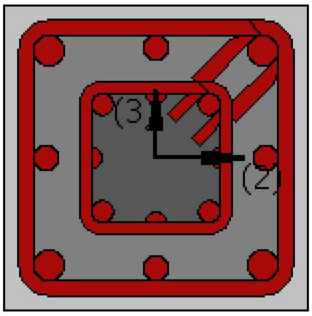
Analysis: Uniform +X

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 = 10.00
Mean Confinement Factor overall section = 1.06329
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 = -8.1187678E-030
EDGE -B-
Shear Force, Vb = 8.1187678E-030
BOTH EDGES
Axial Force, F = -219397.073
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.4563967
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 91510.703
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.3727E+008
Mu1+ = 1.3727E+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- = 1.3727E+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-) = 1.3727E+008
Mu2+ = 1.3727E+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- = 1.3727E+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 = 3.2469244E-005
Mu = 1.3727E+008
---------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
------------------------------------------------------------

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
---------------------------------------------------------------------------
with full section properties:
   b = 200.00
   d = 172.00
   d' = 28.00
   v = 0.19326733
      N = 219397.073
   fc = 33.00
   εco (5A.5, TBDY) = 0.002
   Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: εcu = 0.01053874
      ωwe (5.4c) = 0.03096488
         ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
            ase1 = 0.16608997
               bo_1 = 170.00
               ho_1 = 170.00
               Σbi2_1 = 115600.00
         ase2 = Max(ase1,ase2) = 0.16608997
               bo_2 = 92.00
               ho_2 = 92.00
               Σbi2_2 = 33856.00
         psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
      -------------------------------------------------------------------
         psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
            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 = 0.00100531
               Ash2 = Astir_2*ns_2 = 100.531
                  No stirups, ns_2 = 2.00
               h2 = 100.00
      -------------------------------------------------------------------
         psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
            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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00

d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
---------------------------------------------------------------

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

-----------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
-----------------------------------------------------------------------------
with full section properties:

b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
------------------------------------------------------------

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
---------------------------------------------------------------------------
with full section properties:
  b = 200.00
  d = 172.00
  d' = 28.00
  v = 0.19326733
    N = 219397.073
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01053874
    ωwe (5.4c) = 0.03096488
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
        ase1 = 0.16608997
          bo_1 = 170.00
          ho_1 = 170.00
          Σbi2_1 = 115600.00
      ase2 = Max(ase1,ase2) = 0.16608997
          bo_2 = 92.00
          ho_2 = 92.00
          Σbi2_2 = 33856.00
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
    -------------------------------------------------------------------
      psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
        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 = 0.00100531
          Ash2 = Astir_2*ns_2 = 100.531
            No stirups, ns_2 = 2.00

h2 = 100.00
-----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 200506.935

-----------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 200506.935
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
knl = 1 (zero step-static loading)
--------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
--------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0616465E-011
Vu = 8.1187678E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 200506.935
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
knl = 1 (zero step-static loading)
--------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
--------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0616465E-011
Vu = 8.1187678E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 10.00
Mean Confinement Factor overall section = 1.06329
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 = -1.9686856E-030
EDGE -B-
Shear Force, Vb = 1.9686856E-030

BOTH EDGES
Axial Force, F = -219397.073
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
----------------------------------------------------------------
----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.4563967
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 91510.703
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.3727E+008
Mu1+ = 1.3727E+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- = 1.3727E+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-) = 1.3727E+008
Mu2+ = 1.3727E+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- = 1.3727E+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 = 3.2469244E-005
Mu = 1.3727E+008
--------------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531

No stirups, ns_2 = 2.00
h2 = 100.00
-----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
-------------------------------------------------------------------

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

------------------------------------------------------------------------------

------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
------------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->

v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
-------------------------------------------------------------

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

----------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
----------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
--------------------------------------------------------------------

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
------------------------------------------------------------

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

----------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
----------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->

Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6)  is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
----------------------------------------------------------------------------
----------------------------------------------------------------------------
----------------------------------------------------------------------------
----------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 200506.935
----------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 200506.935
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
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 = 2.0213315E-011
Vu = 1.9686856E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 200506.935
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
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 = 2.0213315E-011
Vu = 1.9686856E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 10.00
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 = -9.9495397E-008
Shear Force, V2 = -37594.437
Shear Force, V3 = 6.2539570E-011
Axial Force, F = -218084.658
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 2001.195
-Compression: Aslc = 1291.195
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 829.3805
-Compression: Asl,com,jacket = 829.3805
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 153.938
-Compression: Asl,com,core = 153.938
-Middle: Asl,mid,core = 923.6282
Mean Diameter of Tension Reinforcement, DbL = 17.50
----------------------------------------------------------------
----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.07272853
θu = θy + θp = 0.07272853

----------------------------------------------------------------
- Calculation of θy -
----------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.03857221 ((4.29),Biskinis Phd))
My = 1.0143E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3147E+012
factor = 0.36521565

Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 218084.658
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 = 3.1087819E-005
with fy = 555.56
d = 172.00
ξy = 0.48050392
A = 0.1071203
B = 0.06705607
with pt = 0.02858484
pc = 0.02858484
pv = 0.03853931
N = 218084.658
b = 200.00
δ'' = 0.1627907
Φy_comp = 2.6249185E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.48728983
A = 0.08130094
B = 0.05564476
with Es = 200000.00
---------------------------------------------------------------

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

---------------------------------------------------------------
- Calculation of θp -
---------------------------------------------------------------
From table 10-8: θp = 0.03415631
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.4563967
d = d_external = 172.00
s = s_external = 150.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00885929
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) = 0.00100531
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 100.00
s2 = 250.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
For the normalisation fs of jacket is used.
NUD = 218084.658
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*ρs1+fy_int_Trans_Reinf*ρs2)/(ρs1+ρs2) = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.09570899
b = 200.00

d = 172.00
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

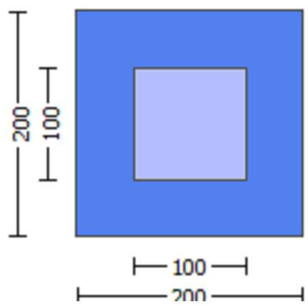
Limit State: Life Safety (data interpolation between analysis steps 50 and 51)

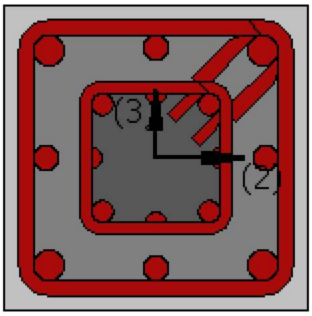
Analysis: Uniform +X

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 = 10.00
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 = -9.9495397E-008
Shear Force, Va = 6.2539570E-011
EDGE -B-
Bending Moment, Mb = -9.0143946E-008
Shear Force, Vb = -6.2539570E-011
BOTH EDGES
Axial Force, F = -218084.658
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 2001.195
-Compression: Aslc = 1291.195
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
Mean Diameter of Tension Reinforcement, DbL,ten = 17.50
-----------------------------------------------------------------
-----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 177628.325
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 177628.325
VCol = 177628.325
knl = 1.00
displacement_ductility_demand = 0.00
-----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.9495397E-008
Vu = 6.2539570E-011
d = 0.8*h = 160.00
Nu = 218084.658

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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 3.1068144E-018
θy = (My*Ls/3)/Eleff = 0.03857221 ((4.29),Biskinis Phd))
My = 1.0143E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 1.3147E+012
factor = 0.36521565
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 218084.658
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 = 3.1087819E-005
with fy = 555.56
d = 172.00
ξy = 0.48050392
A = 0.1071203
B = 0.06705607
with pt = 0.02858484
pc = 0.02858484
pv = 0.03853931
N = 218084.658
b = 200.00
δ'' = 0.1627907
Φy_comp = 2.6249185E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.48728983
A = 0.08130094
B = 0.05564476
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

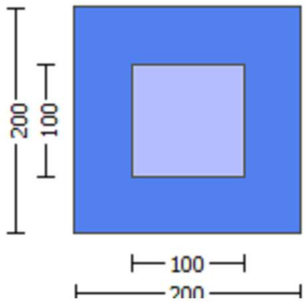
Limit State: Life Safety (data interpolation between analysis steps 50 and 51)

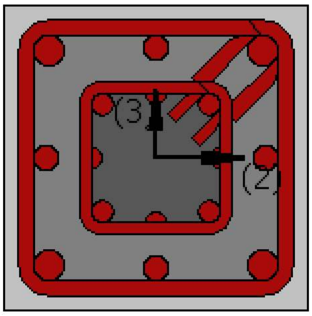
Analysis: Uniform +X

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 = 10.00
Mean Confinement Factor overall section = 1.06329
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 = -8.1187678E-030
EDGE -B-
Shear Force, Vb = 8.1187678E-030
BOTH EDGES
Axial Force, F = -219397.073
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.4563967
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 91510.703
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.3727E+008
Mu1+ = 1.3727E+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- = 1.3727E+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-) = 1.3727E+008
Mu2+ = 1.3727E+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- = 1.3727E+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 = 3.2469244E-005
Mu = 1.3727E+008

-----------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
-----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
--------------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
------------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531

Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
-------------------------------------------------------------

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

Calculation of Mu2+
--------------------------------------------------------------------------------

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
--------------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc  = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied

--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
--------------------------------------------------------------

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

-----------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
-----------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233

---------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
---------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
---------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc  = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6)  is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
---------------------------------------------------------------------------------
---------------------------------------------------------------------------------
---------------------------------------------------------------------------------
---------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 200506.935
---------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 200506.935
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
knl = 1 (zero step-static loading)
-----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0616465E-011
Vu = 8.1187678E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 200506.935
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
knl = 1 (zero step-static loading)
-----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0616465E-011
Vu = 8.1187678E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 10.00
Mean Confinement Factor overall section = 1.06329
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 = -1.9686856E-030
EDGE -B-
Shear Force, Vb = 1.9686856E-030
BOTH EDGES
Axial Force, F = -219397.073
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
-----------------------------------------------------------
-----------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.4563967
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 91510.703
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.3727E+008
Mu1+ = 1.3727E+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- = 1.3727E+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-) = 1.3727E+008
Mu2+ = 1.3727E+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- = 1.3727E+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 = 3.2469244E-005
Mu = 1.3727E+008
--------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo

------------------------------------------------------------

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
---------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329

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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc  = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->

v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6)  is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
------------------------------------------------------------

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
---------------------------------------------------------------------------
with full section properties:
   b = 200.00
   d = 172.00
   d' = 28.00
   v = 0.19326733
      N = 219397.073
   fc = 33.00
   εco (5A.5, TBDY) = 0.002
   Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: εcu = 0.01053874
      ωwe (5.4c) = 0.03096488
         ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
            ase1 = 0.16608997

bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
-----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
--------------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
-----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-----------------------------------------------------------------------
Asec = 40000.00

s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517

ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6)  is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 200506.935
--------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 200506.935
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
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 = 2.0213315E-011
Vu = 1.9686856E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 200506.935
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
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 = 2.0213315E-011
Vu = 1.9686856E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 10.00
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 = -1.3301E+008
Shear Force, V2 = -37594.437
Shear Force, V3 = 6.2539570E-011
Axial Force, F = -218084.658
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 2001.195
-Compression: Aslc = 1291.195
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 829.3805
-Compression: Asl,com,jacket = 829.3805
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 153.938
-Compression: Asl,com,core = 153.938
-Middle: Asl,mid,core = 923.6282
Mean Diameter of Tension Reinforcement, DbL = 17.50
---------------------------------------------------------------
---------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.12513318
θu = θy + θp = 0.12513318

-----------------------------------------------------------------
 - Calculation of θy -
-----------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.09097686 ((4.29),Biskinis Phd))
My = 1.0143E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3537.917
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3147E+012
factor = 0.36521565
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 218084.658
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 = 3.1087819E-005
with fy = 555.56
d = 172.00
ξy = 0.48050392
A = 0.1071203
B = 0.06705607
with pt = 0.02858484
pc = 0.02858484
pv = 0.03853931
N = 218084.658
b = 200.00
δ'' = 0.1627907
Φy_comp = 2.6249185E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.48728983
A = 0.08130094
B = 0.05564476
with Es = 200000.00
-----------------------------------------------------------------

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

-----------------------------------------------------------------
 - Calculation of θp -
-----------------------------------------------------------------
From table 10-8: θp = 0.03415631
with:
 - Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.4563967
d = d_external = 172.00
s = s_external = 150.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00885929
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) = 0.00100531
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 100.00
s2 = 250.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.

For the normalisation fs of jacket is used.
NUD = 218084.658
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*ρs1+fy_int_Trans_Reinf*ρs2)/(ρs1+ρs2) = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.09570899
b = 200.00
d = 172.00
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

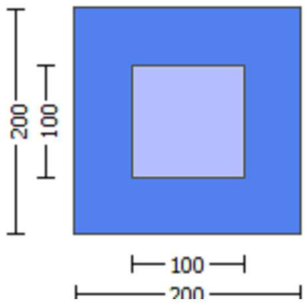
Limit State: Life Safety (data interpolation between analysis steps 50 and 51)

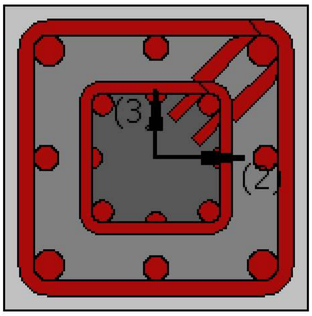
Analysis: Uniform +X

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 = 10.00
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 = -1.3301E+008
Shear Force, Va = -37594.437
EDGE -B-
Bending Moment, Mb = -7.4968E+006
Shear Force, Vb = 37594.437
BOTH EDGES
Axial Force, F = -218084.658
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
Mean Diameter of Tension Reinforcement, DbL,ten = 17.50
-------------------------------------------------------------------
-------------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 175388.999
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 175388.999
VCol = 177628.325
knl = 0.98739319
displacement_ductility_demand = 2.16809
-------------------------------------------------------------------
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 = 7.4968E+006
Vu = 37594.437
d = 0.8*h = 160.00
Nu = 218084.658
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 0.01672561
θy = (My*Ls/3)/EIeff = 0.00771444 ((4.29),Biskinis Phd))
My = 1.0143E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3147E+012
factor = 0.36521565
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 218084.658
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 = 3.1087819E-005
with fy = 555.56
d = 172.00
ξy = 0.48050392
A = 0.1071203
B = 0.06705607
with pt = 0.02858484
pc = 0.02858484
pv = 0.03853931
N = 218084.658
b = 200.00

δ" = 0.1627907
Φy_comp = 2.6249185E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.48728983
A = 0.08130094
B = 0.05564476
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

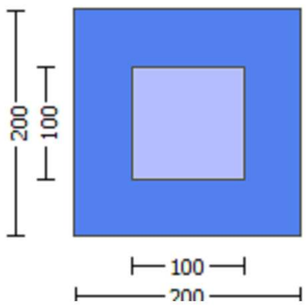
Limit State: Life Safety (data interpolation between analysis steps 50 and 51)

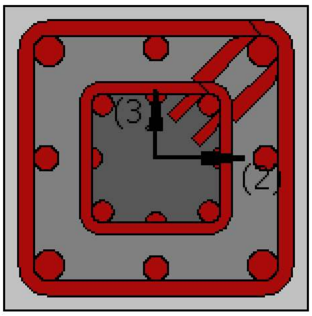
Analysis: Uniform +X

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 = 10.00
Mean Confinement Factor overall section = 1.06329
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 = -8.1187678E-030
EDGE -B-
Shear Force, Vb = 8.1187678E-030
BOTH EDGES
Axial Force, F = -219397.073
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.4563967
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 91510.703
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.3727E+008
Mu1+ = 1.3727E+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- = 1.3727E+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-) = 1.3727E+008
Mu2+ = 1.3727E+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- = 1.3727E+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 = 3.2469244E-005
Mu = 1.3727E+008
---------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover

δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6)  is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
---------------------------------------------------------------

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

------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
------------------------------------------------------------------------------
with full section properties:
   b = 200.00
   d = 172.00
   d' = 28.00
   v = 0.19326733
      N = 219397.073
   fc = 33.00
   εco (5A.5, TBDY) = 0.002
   Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: εcu = 0.01053874
      ωwe (5.4c) = 0.03096488
         ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
            ase1 = 0.16608997
               bo_1 = 170.00
               ho_1 = 170.00
               Σbi2_1 = 115600.00
         ase2 = Max(ase1,ase2) = 0.16608997
               bo_2 = 92.00

ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->

φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
---------------------------------------------------------------

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

------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
------------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
---------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
---------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
---------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00

From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->

v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6)  is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
------------------------------------------------------------

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

--------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
--------------------------------------------------------------------------
with full section properties:
   b = 200.00
   d = 172.00
   d' = 28.00
   v = 0.19326733
      N = 219397.073
   fc = 33.00
   εco (5A.5, TBDY) = 0.002
   Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: εcu = 0.01053874
      ωwe (5.4c) = 0.03096488

ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 200506.935
--------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 200506.935
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
knl = 1 (zero step-static loading)
----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
----------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0616465E-011
Vu = 8.1187678E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 200506.935
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
knl = 1 (zero step-static loading)
----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
----------------------------------------------------------------
λ = 1 (normal-weight concrete)

Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0616465E-011
Vu = 8.1187678E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 10.00
Mean Confinement Factor overall section = 1.06329
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 = -1.9686856E-030
EDGE -B-
Shear Force, Vb = 1.9686856E-030
BOTH EDGES
Axial Force, F = -219397.073
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.4563967
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 91510.703
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.3727E+008
Mu1+ = 1.3727E+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- = 1.3727E+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-) = 1.3727E+008
Mu2+ = 1.3727E+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- = 1.3727E+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 = 3.2469244E-005
Mu = 1.3727E+008
--------------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874

ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
-------------------------------------------------------------

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

-----------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
-----------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00
v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
--------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
--------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00

h2 = 100.00
----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866

εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
-----------------------------------------------------------------

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

---------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
---------------------------------------------------------------------------------
with full section properties:
b = 200.00
d = 172.00
d' = 28.00

v = 0.19326733
N = 219397.073
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01053874
ωwe (5.4c) = 0.03096488
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
ase1 = 0.16608997
bo_1 = 170.00
ho_1 = 170.00
Σbi2_1 = 115600.00
ase2 = Max(ase1,ase2) = 0.16608997
bo_2 = 92.00
ho_2 = 92.00
Σbi2_2 = 33856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
-----------------------------------------------------------

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

--------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 3.2469244E-005
Mu = 1.3727E+008
--------------------------------------------------------------------------
with full section properties:
  b = 200.00
  d = 172.00
  d' = 28.00
  v = 0.19326733
     N = 219397.073
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01053874
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: εcu = 0.01053874
     ωwe (5.4c) = 0.03096488
        ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.16608997
           ase1 = 0.16608997
              bo_1 = 170.00
              ho_1 = 170.00
              Σbi2_1 = 115600.00
        ase2 = Max(ase1,ase2) = 0.16608997
              bo_2 = 92.00
              ho_2 = 92.00
              Σbi2_2 = 33856.00
        psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.15233
     -------------------------------------------------------------------
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
           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 = 0.00100531
              Ash2 = Astir_2*ns_2 = 100.531
                 No stirups, ns_2 = 2.00
              h2 = 100.00
     -------------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.15233
```

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 = 0.00100531
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 100.00
-----------------------------------------------------------------------
Asec = 40000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00263293
λc = confinement factor = 1.06329
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) = 0.60153764

ω2 = Asl,com/(b*d)*(fs2/fc) = 0.60153764
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.8110188
and confined core properties:
b = 170.00
d = 157.00
d' = 13.00
fcc (5A.2, TBDY) = 35.08866
εcc (5A.5, TBDY) = 0.00263293
λc = confinement factor = 1.06329
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.77530517
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.77530517
ωv = Asl,mid/(b*d)*(fsv/fc) = 1.0453
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
δ' satisfies Eq. (4.4)
--->
v < ṽs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
ξcu (4.10) = 0.45915168
MRc (4.17) = 1.5179E+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 satisfied
--->
ξ*cu (4.12) = 0.51649622
MRo (4.16) = 1.3727E+008
--->
φu = φcu (4.2) = 3.2469244E-005
Mu = MRo
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 200506.935
--------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 200506.935
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0

VCol0 = 200506.935
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 = 2.0213315E-011
Vu = 1.9686856E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 200506.935
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 200506.935
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 = 2.0213315E-011
Vu = 1.9686856E-030
d = 0.8*h = 160.00
Nu = 219397.073
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 = 250.00

Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 10.00
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 = -9.0143946E-008
Shear Force, V2 = 37594.437
Shear Force, V3 = -6.2539570E-011
Axial Force, F = -218084.658
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 829.3805
-Compression: Asl,com,jacket = 829.3805
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten,core = 153.938
-Compression: Asl,com,core = 153.938
-Middle: Asl,mid,core = 923.6282
Mean Diameter of Tension Reinforcement, DbL = 17.50
----------------------------------------------------------------
----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.07272853
θu = θy + θp = 0.07272853

----------------------------------------------------------------
- Calculation of θy -
----------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.03857221 ((4.29),Biskinis Phd))
My = 1.0143E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3147E+012
factor = 0.36521565
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 218084.658
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 = 3.1087819E-005
with fy = 555.56
d = 172.00
ξy = 0.48050392
A = 0.1071203
B = 0.06705607
with pt = 0.02858484
pc = 0.02858484
pv = 0.03853931
N = 218084.658
b = 200.00
δ'' = 0.1627907
Φy_comp = 2.6249185E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.48728983
A = 0.08130094
B = 0.05564476
with Es = 200000.00
----------------------------------------------------------------

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

----------------------------------------------------------------
- Calculation of θp -
----------------------------------------------------------------
From table 10-8: θp = 0.03415631
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VColOE = 0.4563967
d = d_external = 172.00
s = s_external = 150.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00885929
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) = 0.00100531
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 100.00
s2 = 250.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
For the normalisation fs of jacket is used.
NUD = 218084.658
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*ρs1+fy_int_Trans_Reinf*ρs2)/(ρs1+ρs2) = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.09570899
b = 200.00
d = 172.00
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

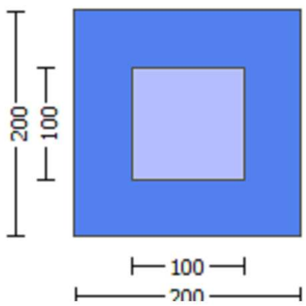
Limit State: Life Safety (data interpolation between analysis steps 50 and 51)

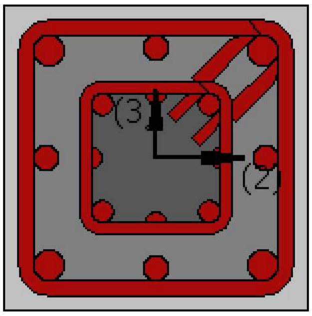
Analysis: Uniform +X

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 = 10.00
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 = -9.9495397E-008
Shear Force, Va = 6.2539570E-011
EDGE -B-
Bending Moment, Mb = -9.0143946E-008
Shear Force, Vb = -6.2539570E-011
BOTH EDGES
Axial Force, F = -218084.658
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 983.3185
-Compression: Asl,com = 983.3185
-Middle: Asl,mid = 1325.752
Mean Diameter of Tension Reinforcement, DbL,ten = 17.50
---------------------------------------------------------------
---------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 177628.325
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 177628.325
VCol = 177628.325
knl = 1.00
displacement_ductility_demand = 2.2204460E-016
---------------------------------------------------------------
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 = 9.0143946E-008
Vu = 6.2539570E-011
d = 0.8*h = 160.00
Nu = 218084.658
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 = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 3.125
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 = 4.2143303E-018
θy = (My*Ls/3)/EIeff = 0.03857221 ((4.29),Biskinis Phd))
My = 1.0143E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.3147E+012
factor = 0.36521565
Ag = 40000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 218084.658
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 = 3.1087819E-005
with fy = 555.56

d = 172.00
ξy = 0.48050392
A = 0.1071203
B = 0.06705607
with pt = 0.02858484
pc = 0.02858484
pv = 0.03853931
N = 218084.658
b = 200.00
δ" = 0.1627907
Φy_comp = 2.6249185E-005
with fc = 33.00
Ec = 26999.444
ξy = 0.48728983
A = 0.08130094
B = 0.05564476
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)

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